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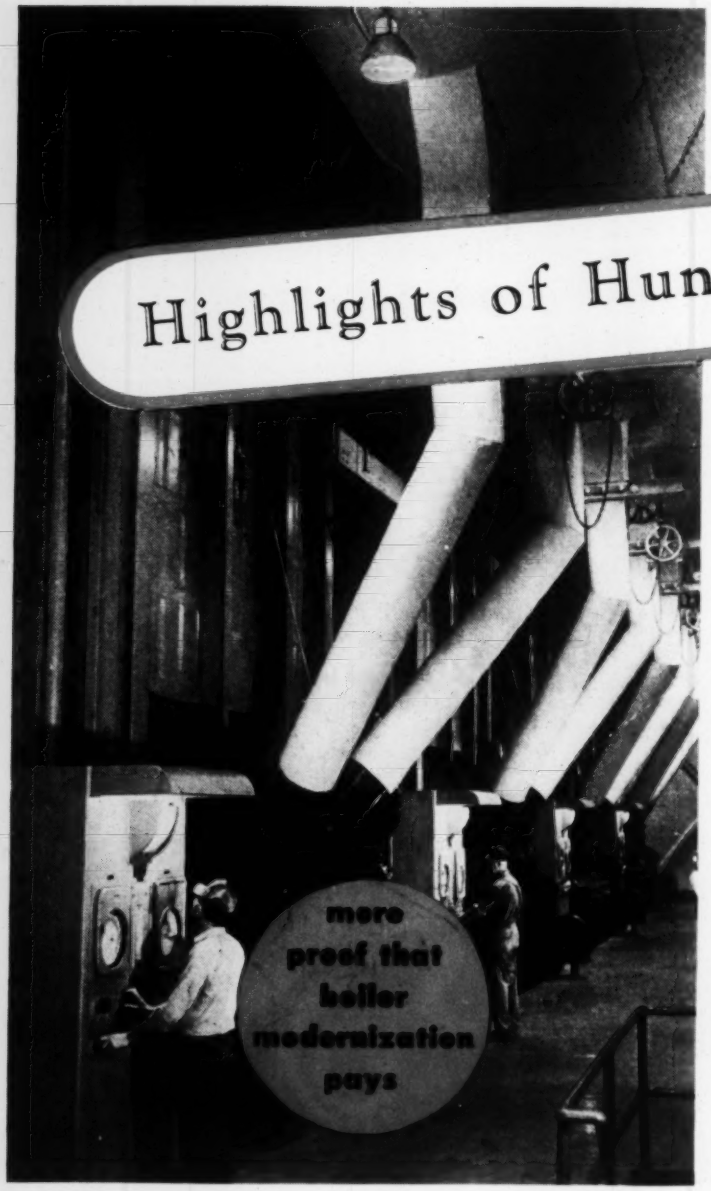

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MECHANICAL ENGINEERING

Published by The American Society of Mechanical Engineers

VOLUME 69 NUMBER 11

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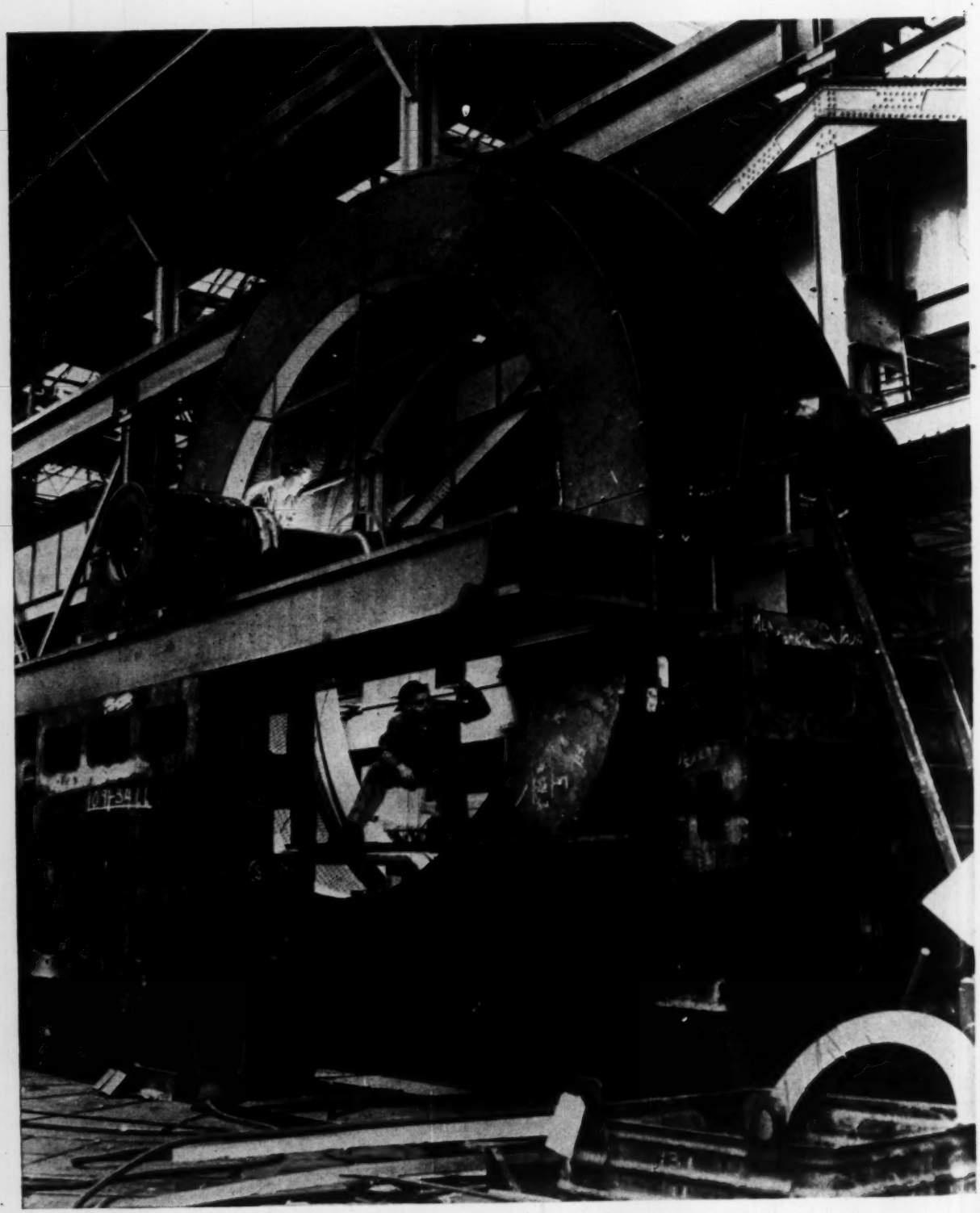

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VOLUME 69
No. 11

MECHANICAL ENGINEERING

NOVEMBER
1947

GEORGE A. STETSON, *Editor*

Professional Recognition

WHEN engineers talk about professional recognition they generally use the term in one or the other of two accepted meanings. One is recognition by the public of engineering as a profession. The other is the recognition by engineers of the right of an individual to call himself an engineer. Both meanings of the term are closely related. If engineers and, particularly, if engineering societies, were in close agreement in their own designations, qualifications, and procedures, there would be less reason than exists today for confusion and ignorance on the part of the public. Uniformity in designating membership grades by engineering societies, more uniform membership qualifications, and more uniform practices in admission and promotion of members would put the engineers' house in order and pave the way toward recognition of the profession by the public.

Nonuniform membership grades, qualifications, and procedures have been tolerated by the engineering profession for many years. When the Engineers' Council for Professional Development was organized fifteen years ago it was the hope and intention of the Council that rapid progress toward uniformity in these matters would be made. The task of leadership toward this desired objective was assigned to the Committee on Professional Recognition which studied the subject and made recommendations to the societies. In such matters, however, E.C.P.D. has no authority beyond the making of recommendations. Action on such recommendations must be taken by the individual constituent societies which make up the Council. As a result, fifteen years have passed and the societies are little nearer uniformity today than they were in 1933.

The passage of time has done little to lessen the desirability of doing something toward greater uniformity. In so far as legal recognition is concerned the growth of registration of engineers has reached the point where today every state in the Union has a law which requires a license to practice. Legal recognition, however, is not a complete substitute for the professional recognition engineers are striving for.

Because engineering societies are made up of persons having widely different degrees of competence and experience they have found it necessary to establish several grades of membership. These vary from the student grade, comprising young people still in college, to grades which are open only to the most eminent practitioners of the profession. The necessity for recognizing several grades of membership is generally accepted. What is objected to is the lack of uniformity in the names given by the individual societies to essentially equivalent grades. It is confusing to the engineer and to the public when one society uses "junior" and another "associate" to designate what are essentially persons in the same classification by age and experience; or to find that "associates" in one society are called "affiliates" in another when both societies are attempting to set up a grade of membership for nonprofessional persons closely allied to and interested in the engineering profession. As a first step in uniformity it would seem to be not an impossible task to secure agreement on the part of the engineering societies to a common set of membership-grade designations.

The second step is more difficult. If designations are to have significance there should be general agreement on the qualifications of persons admitted to any of the uniformly titled grades of membership. A study of the requirements for membership in engineering societies will show that, particularly in the upper grades, age limits and years spent in responsible charge of engineering work differ widely. Obviously, the right of a society to establish its own requirements for membership cannot be challenged. No society with high standards should be expected to relax them. A general raising of membership qualifications to enhance and protect the prestige of grades which connote professional status and competence should be the aim of all engineering societies.

The third step toward uniformity must be taken by the membership boards of the engineering societies in the administration of admission and promotion procedures. Uniform designations of grades of membership and high standards of education, training, and professional practice are meaningless in so far as recognition is concerned if admission and promotion procedures are lax or perfunctory or do not involve a thoroughgoing and impartial scrutiny of the records of every candidate. Not even the man himself prizes a distinction he has not won or one lightly conferred upon him. When lax procedures admit men to grades of membership to which they are not entitled to belong, every member of that grade who has earned his passage into it finds cheapened something he values highly and the cause of professional recognition suffers a set back.

Recognition by the public of engineering as a profession will be favorable and widespread when engineers have earned it and when engineers themselves have developed fairly uniform standards by which they recognize the competence and attainments of their fellows. The matter is in their hands. Let the societies which are constituent members of the Engineers' Council for Professional Development set the pace, agree among

themselves on uniform grades which will have meaning to professionals and laymen alike, raise the standards to be met by persons admitted to membership and advanced to higher grades, and administer their rules and procedures with thoroughness and watchful care, and the profession will advance in public esteem and be accorded the recognition it deserves.

A Task for Engineers

ENGINEERS who heard Leonard J. Fletcher address the Citizenship Luncheon at the Chicago meeting of The American Society of Mechanical Engineers last June were greatly impressed by the intense sincerity with which he urged upon his audience the seriousness of the threat to the American way of life and by the challenge he threw out to them to do something about it in a practical way. The substance of Mr. Fletcher's address is contained in an article which appears in this issue.

The world is plagued by conflicting ideas of social, economic, and political doctrine. Those to which we in the United States give our allegiance are so at variance with those of eastern Europe that compromise and agreement seem to be hopeless. It is indeed difficult for us to imagine how other human beings can be so perverse as to hold ideas contrary to our own. We are so convinced of the righteousness of our own cause and of the superiority of our own way of life that we cannot bring ourselves to believe that the whole world is not willing and eager to embrace them, given a chance to do so. It is difficult to imagine what our own attitude would be were the places reversed and had we been brought up under conditions and philosophies which prevail outside our borders. And yet, with strong protestations of our own beliefs and with sincere abhorrence of contrary ones, few of us could put into words that would withstand the shock of intelligent argument just what it is that we have faith in or just what it is about the other fellow's point of view that conflicts with our own. So subtle are these matters that many of our statements taken literally, as well as many of our actions and institutions, can be shown, by a clever disputant, to be based on principles contrary to those we profess to hold and basic to the philosophies we claim to discredit.

Here lies the danger. Our objections are directed against catch words and symbols just as our allegiance is given to a traditionally familiar set of names and phrases. In general we know of conditions existing in other nations under which we could not live. In general we imagine that in our own country there are few conditions which a normal human being would be unable or unwilling to accept. We sense the inevitable conflict of these ideas and are apprehensive of the outcome of the conflict. But if the ideas to which these catch phrases and symbols have been attached are broached to us in disguised language by plausible talkers who are not apparently allied with the opposing camp, we frequently assent to them innocently because we do not examine them in the light of their ultimate implications. As a single example which has been frequently used, many persons admired the early successes of Fascism in Italy because they did not understand how contrary its fundamental principles were to those for which their forefathers fought. It is human nature to approve schemes which seem to benefit us as individuals or which appear to be in harmony with objectives we sincerely approve without examining closely, assuming we have the knowledge and intelligence to do so, what basic principles are involved. And frequently when the ends themselves seem to be worth while the means are misinterpreted or are accepted as being justifiable.

The British voted into power a Labor Government that was committed to an extensive nationalization program. One of the first industries to be nationalized was the coal industry. Undoubtedly a majority of miners voted for the Labor candidates and approved the nationalization idea. To date, nationalization has not brought the millenium to the British. They have lacked coal for necessary domestic uses and they have had little or none for export at a time when their economic life depends on exports. They have faced a crippling strike by miners who presumably voted for the change. It has been said by competent persons that the miners misunderstood what nationalization meant. Some, apparently, believed that under nationalization they, the miners, would run the mines and the settlement of their grievances would be in their own hands. Although many concessions were made to the miners, what actually happened was that private-owner control passed into the hands of state control. In most cases the same "bosses" were over the men. In so far as appearance went conditions were much the same. Change of ownership did not relieve the nation of its desperate need for fuel. It did not reduce the amount of labor involved in getting coal out of the ground. It did not lessen the amount of coal every miner had to dig in order to provide for the national demand. Whatever the long-range result may be, it is probably true that many miners have been disappointed in the immediate effects of nationalization. How much of this disappointment could have been avoided no one can tell. It is not likely that proponents of the nationalization program would have stressed the difficulties of putting it into effect. It is easier to point out abuses than to correct them; it is easier to raise hopes than to fulfill them. Most of us lack objectivity in assessing the probable benefits of change and are easily convinced that a change is an improvement.

It is a strong feature of Mr. Fletcher's plea that it exhorts engineers to be informed on matters of fundamental importance to everyone, to listen to the other person's point of view, and to have sound methods and arguments in directing his thinking into profitable channels. His challenge is to all of us, not to do the impossible in leading the thought of the Nation but to influence to their advantage the people who live in our communities. His program calls for personal sacrifice of time and energy. The result of a successful prosecution of his program would make us more thoughtful, more useful, and more intelligent citizens and would serve greatly to counteract alien propaganda, subtly disseminated and alluring to the unwary.

Progress in
SCIENTIFIC MANAGEMENT

By H. S. PERSON

NEW YORK, N. Y.

THE progress of scientific management in the United States presents somewhat of a paradox (1).[1] There is scarcely an enterprise of stability and consequence, of whatever size, that has not been touched by its influence at one point or another. The cumulative effect played an outstanding part in recent amazing war production. Yet there are few individual examples of comprehensive integrated scientific management. This paradox is one of the most interesting and significant aspects of scientific management's progress, and we shall find it desirable to consider it more fully.

BEGINNINGS OF SCIENTIFIC MANAGEMENT

The origin of scientific management can be identified and dated. It is a product of the genius of Frederick W. Taylor, first worked out in the solution of day-to-day problems at the Midvale Steel Company in Philadelphia, the Bethlehem Steel Company, and elsewhere during the years 1880–1900. Taylor's subsequent expositions of origin, technique, principles, and philosophy are now classics (2). The fact that scientific management was something new is evidenced by the response throughout the industrial world—whether of curiosity, interest, imitation, enthusiasm, perplexity, or controversy—to Taylor's proposals. Successful management was a familiar phenomenon, else there would have been no industry at the time of Taylor's advent; and there had been various efforts to improve details of management, notably in the field of accounting, especially in England (3). But Taylor offered a new approach and constructed an integrated whole of procedures that was as new as the Wright brothers' first aeroplane, although, likewise, many of the parts considered separately were known mechanical devices.

The scientific-management technique, and the principles derived therefrom, had scope, scientific substance, and integrity. It brought organized inductive science for the first time to the homely affairs of the shop (4) and subjected unit and composite elements of the management process to measurement, appraisal, and control. It gave a factual substance to what Babbage and Ure had sensed in England half a century earlier (5), to what contemporaries like Fayol in France (6), and Ademieki in Poland (7) were striving to formulate a priori; to concepts that in Germany came to be included in *rationalizerung;* and it provided a foundation and frame for accessory contributions by associates such as Carl G. Barth, Morris L. Cooke, Henry L. Gantt, and Frank B. Gilbreth (8).

TECHNIQUE, PRINCIPLES, AND PHILOSOPHY

It is not essential to our purpose to consider technique in detail, but somewhat more attention must be given to principles and philosophy. The technique consists of two major parts, each much less fruitful without the other: (*a*) Discovery through every resource of scientific method of the natural laws—physical and psychological—that govern a particular management situation; and (*b*) construction of a frame of managerial conduct, or methodology, that observes these laws. The essence of the matter is that the technique is not a scheme of managing in a particular situation, but is a mode of approach to discovering and establishing what the scheme of managing should be for the particular situation. The resultant methodology suitable for each situation, although it will employ commonly useful elements, will in its entirety be unique for each situation. I have observed only one enterprise—a multiple plant enterprise whose plants, although geographically scattered, produced the same line of products—in which, because of years of patient determined direction by the same owner-manager, conditions at the constituent plants have been brought to such a degree of similarity that the details of scientific management in any one of them are essentially the same as in the others.

Interest in these new industrial practices started intensive and widespread discussion, in the course of which Taylor was stimulated to interpret them in terms of principles and philosophy. The very heart of it, he said, was the rule of law, which must replace unsupported individual opinion usually reflecting "thumb-rule," guess, or ignorance. Observance of the rule of law means a mental revolution on the part both of management and of workers. This mental revolution must include recognition that management and labor have more in common than in conflict; that co-operation is the essence of the management-worker relationship; that this co-operation calls for the assumption by management of previously evaded responsibilities definitely related to processes of production; that among these responsibilities is organization of research to discover managerial laws; formulation of the results of research in the form of standards of purpose, facilties, processes, and methods easily understood by management and workers alike; and managerial initiative in facilitating production through planning of, and preparation for, all operations.

Taylor held that the resultant increased productivity would afford opportunity for higher wages, but he conceived higher wages not as a stimulant to greater effort but as a reward, in a sharing of the greater productivity, for the essential co-operation. From the larger social point of view, he recognized that there was lack of apparent relationship between good management and dividends, especially in a pioneering exploiting economy. But he insisted that, other things being equal, which they tend to be as an industry matures, the quality of the management is the determining factor as to earnings. Progress and social betterment, he declared, must come from the greater productivity which results from economy of human and natural energies; also progress on this basis is essential to the opportunity for moral and spiritual growth on the part of all associated with industry, and to the preservation of democratic institutions.

[1] Numbers in parentheses apply to the References at the end of the paper.

Presented at the Eighth International Management Congress, Stockholm, Sweden, 1947. The author was awarded the C.I.O.S. Medal at this Congress.

RATIONALE OF THE PARADOX

The mental revolution and the related radically new pattern of management and worker habits required by the scientific-management technique give a clue to understanding of the paradox referred to at the beginning of this paper—why, notwithstanding its profound influence on industry in the United States, there are few individual examples of integrated scientific management. These requirements identify scientific management as a "social force;" quite a different order of institution from a transferable mechanistic scheme of managing. As is true of any social force, the objective results of impact are determined as much by the conditions at the point of impact as by the nature of the force.

In respect of scientific management, the understanding, resolution, guiding skill, and patience of the management and the quality of relations with labor are the most important factors in the response; but also of major importance are the purpose and nature of the enterprise; the plant, equipment, and other limiting physical conditions; cumulative crystallized habits, which cannot be eradicated by fiat, but must be faded out gradually by the learning of new habits; and the skill characteristics of the working force. For these reasons, scientific management calls forth great variety of reactions, reflecting the great variety of comprehensions and capacities of those who undertake its development, the great variety of resistances in the crystallized situations on which the impacts are made, and the infinite variety of permutations of these. Too few managers understand that development of and considerable realization from scientific management are matters requiring several years and that they should not start on so rigorous a road unless they have the courage and perseverance to see it through. Some scientific-management developments have been patient, studious, understanding, and outstandingly successful; some hasty, uninformed, superficial, and therefore unsuccessful; some are the expressions of commercialized quackery; most of them are sincere, but not adequately informed, and leave a residue of mechanistic betterments in spots but not an integrated over-all scientific management.

Taylor stressed the necessity for total integration, for the interweaving of every aspect and function into a single hierarchy of defined objectives, harmonious approach, and studied detail. Better, he thought, and his experience justified him, to have the entire enterprise scaled to a uniform—even low—standard of effectiveness than to have the constituent parts vary widely in their rated performance, and thus inhibit the integrated effort.

This distinction between total integration and capricious utilization of mechanisms is important, however much the use of mechanisms may appear to improve existing methods and productivity. The integration itself is a more potent factor than any mechanism or group of mechanisms. Then too, without perfect examples of the integrating factor clearly in view, the process of appropriation and adaptation of mechanisms tends toward deterioration. This appears to be the trend in the United States.

QUANTITATIVE MEASUREMENT OF PROGRESS NOT PRACTICABLE

Progress in scientific management is not susceptible of practicable quantitative measurement. Prior to the development of scientific management, no two managerial situations and no two managements were identical in their characteristics. Similarly, after the impact of scientific management, no two responses and resultant managements are identical. Because of this variability of reactions to impact, progress refuses to be bound by the most fundamental of statistical laws—homogeneity of units of observation. The statistician is confronted by the fact that there are as many classes as there are units, and any manageable statistical reckoning is impossible. Qualitative differences among observation units neutralize quantitative considerations.

Scientific management as a social invention is "a universal mode of approach to discovering and establishing" the particular management policy and methods most suitable for a particular situation; and although experience has demonstrated that certain validated elements have application in all situations, there can be no forecast of what any particular management is going to be in all its details after the laws of the situation have been discovered.

RESPONSIVE TYPES OF ENTERPRISES

The types of enterprise which have been most responsive to the advantages of scientific management may be classified as follows:

(*a*) A few small or medium-size establishments which happen to have owners, usually owner-managers, who, without necessarily being engineer-trained, are of the engineering temperament; who instinctively seek orderly arrangement and the conduct of operations on the basis of calculation; who combine with this temperament the qualities of leadership which enable them patiently to carry through the building of a new pattern of habits without impairing current operations.

(*b*) A few small or medium-size establishments whose owner-managers may not have an impelling instinct for orderly arrangement and perfection for its own sake, but who have a temperament which seeks long-run stability; who develop for the enterprise orderly arrangement and a pattern of habits which promote discovery of, and adjustment to, change in technology, the economy, and the market. These owner-managers also must possess qualities of effective leadership which enable them to guide change from old to new habits of management without impairment of current operations.

(*c*) A substantial number of large enterprises whose processes are such as to involve an extremely large investment in specialized fixed capital which constitutes a hostage given to the future and creates strong motivation for seeking, through the best in management, a long life for the investment. These large enterprises can spread the cost of management betterment over a huge volume of business and can support it as a continuous specialized activity. However, it should be noted concerning these giant enterprises that, from a management point of view, they are essentially confederations of quasi-autonomous smaller enterprises, subject to direction at the highest level in respect to strategic matters, but in which the degree of achievement of scientific management in operations depends upon the understanding, energy, patience, and leadership of the various constituent plant managements. So large are these constituent plants that unevenness is as marked among departments of a plant as among plants (9).

Otherwise, throughout industry in the United States the response to scientific management is extremely spotty and is represented by fragmentary developments, usually restricted to mechanisms, such as time study, in contrast to a comprehensive and integrated body of procedures involving finance, marketing, purchasing, and primary production. In other words, this widespread appropriation of mechanisms, generally without integrated relationship, represents an influence of scientific management but not scientific management itself.

It should be noted that neither mechanization, mass production, mass assembly, nor mass selling is scientific management or necessarily a response to it. These are distinct parallel forces. In any particular situation, scientific management may demand or may disapprove one or another or all of these; it depends chiefly upon the product, the process, the market, and the vol-

ume, a set of controlling factors, analysis of which scientific management makes its first step.

PROGRESS AS TO PHASES

Progress in scientific management is best indicated by the spread of its development in respect to various major phases of management.

It is well known that scientific management was first developed in the production or fabrication area, was restricted to that area for a period of about 40 years, and today presents its most complete and perfect examples in that area. This is because production is concerned chiefly with behavior of physical matter which responds to experiment and other research and manifests dependable laws of behavior in terms of which standards may be formulated and effective control procedures established. The development in management areas where human behavior is the dominating factor is more complicated and more difficult, and largely for that reason more recent.

Two years after the armistice which ended the first world war there was in the United States a slump, following a sharp rise in prices, sometimes called the "depression of frozen inventories" because inventories were vastly out of proportion to sales and had to be liquidated at a substantial loss. This, and other problems of readjustment brought into high light several outstanding deficiencies of management in the United States at that time. Production technique had progressed to a point far out of line with other phases of management; marketing, as a phase of management, was expedient rather than calculated and controlled; co-ordination of sales, production, and other departments by top administrators likewise was expedient and without planning and control. Recognition of this situation turned attention to the possibility of applying the scientific-management approach so effective in production to the organization and control of marketing and of general administration. In less than a decade outstanding achievements in both of these new directions were on record.

Marketing in the most advanced managements has developed a technique involving measurement of such factors as consumer demand, competitive supply, the qualities and training most suitable for developing effective sales people, the most effective methods of selling, and the most suitable channels for getting products to consumers. It formulates standards in the nature of quotas expressed in terms of items of product, territories, salesmen, and variable monthly or quarterly volumes. It plans and controls selling in terms of these standards, checks progress, and brings remedial measures to bear when deviations are observed (10).

In the most advanced managements, top administration has developed a technique reflecting scientific-management influence. This is especially true of large corporations. It aims at maintaining co-ordination of all the functions of enterprise, namely, marketing, production, purchasing, financing, and employment. It pivots on the budget as an embodiment of standards and an instrument of planning and control. Beginning with the marketing forecasts, program, and schedules, it reduces these to equivalent schedules for production, purchasing, employment and financing; and then reduces all to terms of expenditures by functions. Expenditure deviations become the basis of action and control; with an eye constantly on the "break-even point" at various volumes of sales, either modification of schedules is made to meet changed market conditions or modification of activities to conform to established schedules. There is here involved research, standards, planning, and checking of progress for effective control (11).

LABOR RELATIONS AND PERSONNEL MANAGEMENT

The development of personnel management and labor relations has been profoundly influenced by scientific management, but also it has been as profoundly influenced by parallel social forces. By 1900, ten years before scientific management was brought generally to the attention of industry, humanistic thinking was beginning to have an influence on employer-employee relations. Simultaneously, the experience of the larger corporations was focusing attention on the fact that mass employment called for organization of personnel management to compensate for the lost personal contacts among employers and employees of simpler industrial enterprises. Mechanization and meticulous care for equipment generated the point of view that labor also is a factor in production which requires maintenance in good condition of health and skill. Here and there the very advanced view appeared that the good will of labor is itself a factor which contributes to effective production (12). This movement expressed itself chiefly in provision for adequate light, heat, ventilation, rest rooms, corporation schools for development of skills and interest, and an occasional organization of workers' committees for co-operation with management. Accompanying these developments, and one of the most powerful forces, was the pressure of increasingly strong labor organizations. In the background was the then mild influence of industrial psychology which was beginning to find a place in university teaching (13). This was the situation in respect to employer-employee relations which was prevalent among most advanced managements when, in 1911, scientific management made its impact on American industry.

The major contribution of scientific management to employer-employee relations and to personnel management is that it stimulates research and the development of objective standards throughout all phases of management, and in particular that these standards offer a solid factual basis for effective application of the good-will theory. A collateral contribution is that the solid factual basis keeps leadership, both of management and of labor, in step with economic change. It is not possible to overemphasize the beneficent influence on personal relations in industry of the elimination of executives' and foremen's direction of work by guess and arbitrary orders, and the substitution therefor of definite standards of routing, timing, quality, quantity, materials, tools, methods, and working conditions generally, understood by the worker as well as by the management. It gives management and workers a common factual language, and places both in a position to make more rational and demonstrable requests and to work together in a more co-operative atmosphere. It weakens management's position of arbitrariness, but strengthens its opportunity to increase output and reduce costs; it strengthens labor's efforts to win functional status and an increased share of an increased productivity. It has not solved the problem of employer-worker conflicts, but it has lifted it up to the higher level of concern for facts, and in that respect carries the potential of solution much nearer to becoming a fact.

This potential made it possible for scientific management to pioneer in advocacy of labor's participation in fact-finding and the development and use of standards; and for a labor leader, Sidney Hillman, to lift an entire industry from a level of chaos to one of relatively high morale. Labor generally has not become an advocate of scientific management any more than has management. The curious paradox exists of no serious labor friction in plants where bona fide scientific management has been understandingly, honestly, and patiently developed, yet of indifferent esteem on the part of organized labor's officials. This indifference appears to be strategic; a part of the campaign to win recognition of functional status and functional participation in the development of scientific management in order to assure that it is bona fide (14).

DORMANT AREAS

Several management areas have resisted the progress of scientific management in the United States. It is conspicuously absent from public administration. Although students of public administration reflect its influence and some progress has been made in its development in quasi-public agencies, such as TVA and in isolated sectors of other public agencies, generally the crystallized mass of bureaucratic institutions and practices appears to be as impenetrable as a bale of cotton. A notable exception is found in the operations sectors of the military establishments, where may be observed some of the best scientific management in existence. National planning of a scientific-management quality is conspicuously absent, although the recent establishment of a Council of Economic Advisors may represent an infantile step in that direction.

Scientific management has not made any notable impression on the day-to-day conduct of farm operations, although its influence is felt indirectly through improved and less costly farm equipment made available by industrial scientific management. The Department of Agriculture has brought science to bear on many farm practices, and, aided by the establishment of the income tax, has stimulated better record keeping and accounting. But there are only isolated instances of influence on the over-all management of a farm. There is ground for hope that experimental time studies of the more common units of agricultural operations now being conducted under the auspices of several educational centers will eventually have a stimulating effect.

Scientific management's influence on household management has been very limited and chiefly indirect. There has not been formulated any standard technique of management of the household, but there has been fairly notable progress in functional arrangements of the household plant, especially the kitchen, and in the development of laborsaving equipment. These have come rather from scientific management's influence on industrial enterprises producing for the home as their specialized market.

Both the farm and the household are the surviving strongholds of individualism; the household is not a center of production for a market, and farming is as much a way of living as a production center. Neither is accountable to a body of investors outside the center of management.

Wholesale and retail merchandising, in contrast to manufacturers' marketing, has hardly been touched by scientific management. Wholesale and retail enterprises have made progress along lines of systematization and mechanization of processes; but generally they have not responded to the concepts expressed in the basic principles and technique of scientific management. A few exceptions are to be found among large department and chain stores, and in respect principally to top co-ordination of departments, and controls of purchasing, storage, delivery, and related control of stocks.

Enterprises generally classified as commercial, with a few notable exceptions, also have shown little response to the scientific-management principles and technique. The few outstanding exceptions are in the communications and insurance field. Of transportation, it may be said that the findings of the Eastern Rate Case Hearings in 1910–1911 are still largely pertinent. Banking, which employs to an increasing extent mechanical aids to processes, is still in the stage of systematic management as contrasted to scientific management.

Generally, throughout all areas of management, including industry, there is absence of over-all perspective and of a comprehension of scientific management as an integrated whole of procedures involving a balance among research, standardization, and control arrangements. Of late, the interest has been focused on mechanisms and devices, such as motion-and-time study, which have their value, but a value that is limited when not part of an integrated management pattern. Specialization in mechanisms and phases has become dominant, and perspective has been sacrificed.

This is true of the profession of industrial engineering. Unregulated, free from prescribed education and training, and open to all comers, it is on the whole not genuinely a profession. For every consultant of large vision and command of a responsible technique there are a score without perspective and with command only of a technique of commercialized expediency. These latter are an obstacle to progress in scientific management. With respect to them, it may be said, paraphrasing a sentence concerning politics from Sir Ernest Benn: "The common garden variety of industrial engineering is the art of looking for trouble, finding it everywhere, diagnosing it wrongly, and applying unsuitable remedies."

Perhaps the most serious aspect of all is absence of suitable education and training in scientific management, and the failure to develop among industrial engineers and managers what may be called transferable professional ability, reflecting command of a technique of approach to the discovery and development of a scheme of management for any situation wherever it may be found. While there are many educational institutions which offer training for business life, and some of them offer one or two courses with a management label, none of them teaches scientific management with the requisite perspective. Either consideration of scientific management is one element in a liberal course without technical substance; or if it be given a place in a technical course, attention is concentrated on mechanisms such as motion-and-time study. Scientific management is really taught only when the scope embraces principles, philosophy, and the pertinent mental revolution; and when every phase of the technique of fact finding, development of standards, and making the indicated control arrangements is included in rational weighted relationship. To promote perspective scientific management should be taught in one comprehensive course covering production, marketing, top administration, and employer-employee relations. One of scientific management's principal tasks is to give meaning to all the specialized instruction. Limited time and overspecialization at present make the instruction fragmentary and ineffective.

In the United States, the significance of scientific management is beyond the range of interest of organizations of commerce and industry. To be sure, there are management societies, but these are associations of individuals rather than of entire industries or of all industry; and, although they make much use of the term "scientific management," they give too little attention to its substance. No association of manufacturers has a unit for promotion of scientific management or for guidance of its members in their attempts to develop it, which is in contrast to the example set by the Sveriges Industriförbund of Sweden.

SCIENTIFIC MANAGEMENT NOT NATIONAL

Although, because of a unique combination of circumstances, scientific management originated in the United States, the institution itself does not recognize nationality. It may find manifestation wherever organized activities of any nature are conducted, and wherever there is the motivation and intelligence required for its development. It is not at all improbable that in the future we shall see the highest development of scientific management in other countries and in smaller countries than the United States. The devastating influence of the recent war on the economies of many countries provides the motivation; in them the necessity for intensive organization for recovery through most effective and economical utilization

of human and physical energies is paramount. They are possessed of unexcelled intelligence. This combination of necessity, intelligence, and the availability of a proved and adaptable technique establishes the probability.

THE HORIZON OF SCIENTIFIC MANAGEMENT

Scientific management, in essence a great social force, had modest beginnings more than half a century ago as a technique of conserving human and material energies at the isolated workplace. Its influence progressively spread to the shop, the entire production department, the entire enterprise, and to the multiplant enterprise. It was conceived as a technique of reducing waste, increasing productivity, and not only permitting but, so great is its dependence on goodwill and co-operation, requiring an equitable sharing of the increased productivity. It is a technique which may be employed in increasing and effecting equitable utilization of the human and material resources of an entire nation, but that calls for the same spirit of co-operation and goodwill on the national scale as is required in the workshop and the unit plant. It is a technique which may be employed in increasing and effecting equitable utilization of the human and materials resources of an entire world. That requires on a still larger scale, the same spirit of co-operation and good will as is required on the national scale.

We have but to lift our sights and explore the new horizon with nobler perspective. Never can the need for scientific management be more urgent than in a world torn to chaos by global war. Never can the way be more open for achievement than now, when habits and institutions and ideals and economies have been shattered, and we set ourselves to the great task of assembling the parts, revaluing them, rearranging them, and building a new world that affords life, liberty, assured livelihood, and the pursuit of true happiness, commonly shared, the world over (15).

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MECHANICAL ENGINEERING RESEARCH IN BRITAIN

By THOMAS C. CRAWHALL

SECRETARY TO BRITAIN'S MECHANICAL ENGINEERING RESEARCH BOARD

A NEW organization has been set up by Britain's Government to carry out scientific research in mechanical engineering to meet, and anticipate, the needs of industry and of Government departments.

A committee, appointed some time ago by the Government's Department of Scientific and Industrial Research to investigate the essential needs for research in this field and to examine the research facilities available, reported that, allowing for the considerable amount of research already in progress in Government establishments, at universities, at some of the Industrial Research Associations' establishments, and in the research departments of the larger firms, there still remain considerable gaps in research, such as those existing in research in hydraulic machinery, in heat-transfer and heat-exchange problems and apparatus, in applied thermodynamics, and in kinematics and mechanisms.

In addition to these gaps and, perhaps, even more important, the Committee emphasized the need for much more extensive research on the more fundamental and generic problems of engineering science, on which mechanical engineering practice of the future very largely depends.

The Government has therefore appointed a Mechanical Engineering Research Board, under the chairmanship of Dr. H. L. Guy,[1] member and secretary of the Institution of Civil Engineers, member of The Institution of Mechanical Engineers, and fellow of the Royal Society, who was also chairman of the committee which investigated the position. The terms of reference of this Board are: (1) To advise generally on the research to be undertaken by the Mechanical Engineering Research Organization; (2) to submit annually programs of research and to advise on the conduct of approved investigations; (3) to submit annual reports.

NEW ESTABLISHMENT TO BE BUILT

As with all other research organizations of the Department of Scientific and Industrial Research, the members of the Board are selected from among eminent scientists and technicians and from industrialists in the field of mechanical engineering. Because of the need for a close relationship with electrical and civil engineering, there is also a representative from each of these interests on the Board. The other interested Government departments are represented by assessors. Dr. G. A. Hankins, M.I.C.E., M.I.Mech.E., superintendent of Britain's National Physical Laboratory, has been appointed director of Mechanical Engineering Research. With the help of the Board and its committees he is busy planning the program of research and the design of the laboratories.

As soon as building conditions permit, a new establishment will be erected to provide a convenient center for experimental work. Groups of research workers will be organized in each of the main branches and the necessary equipment, some of it on a large scale, will be designed and installed.

The subjects in which research will be carried out can be summarized as follows, and committees to advise the Board on various aspects of the work are being set up and have, in some cases, already met:

(1) The expansion of research already in progress on the basic properties of materials at high and low temperatures and their application to design problems. The work at high temperatures is of the greatest importance in increasing the efficiency of heat engines of all kinds; the work at low temperatures has direct applications in the design of refrigerating machinery.

(2) General development and applications of elastic theory to mechanical-engineering design; also the building up of a research team fully competent and properly equipped to tackle the numerous vibration problems which arise in modern mechanical engineering.

(3) Detailed study and application of fundamental knowledge of fluid mechanics to mechanical-engineering problems; steam turbines, and boilers, and hydraulic machinery of all kinds are particular examples.

(4) A fuller understanding of the behavior of lubricants, both mathematically and physically, not only in journal bearings, but in oscillating motions and in gears; and, in co-operation with chemical research, the development of improved lubricants.

(5) The basic science of kinematics and mechanisms, which is fundamental to the design of machine tools and production machinery of all kinds. This work has been neglected in Britain but the new organization will remedy this. Engineering metrology and accurate measurement is of very great importance in many branches of engineering and requires further development; an important example is the measurement and assessment of surface finish of machined parts.

(6) The manipulation of engineering materials and the production of various components by pressing and shaping is still based almost entirely on practical experience; the basic mechanics of this subject must be developed. Similarly a vast store of practical knowledge exists on the machining, shearing, and cutting of engineering materials but the basic mechanics or physics of these operations is still largely unknown.

(7) Problems in heat transfer are common to almost every branch of mechanical engineering and much further investigation is required both in the basic science and in the application of existing knowledge to detailed design. Knowledge of thermodynamic properties of working fluids in heat engines and refrigerating machinery over a much wider range of temperature and pressure than is at present available is highly necessary for future progress.

Eventually some £250,000 to £350,000 ($1,000,000 to $1,400,000) will be spent annually, although it is unlikely that this figure can be reached for some years because of the difficulties in obtaining staff and buildings. This money will be provided by the Government. In the interim, before laboratories are built, the fullest use will be made of existing facilities, particularly those at the National Physical Laboratory and in the mechanical-engineering faculties of the universities. Close contact will

(*Continued on page 906*)

[1] Dr. Guy is a Fellow of The American Society of Mechanical Engineers.—Editor.

HEAT-PUMP SYSTEM *Using* WATER STORAGE

Description and Performance of a Heat-Pump Air-Conditioning System for an Industrial-Control Building

BY PHILIP SPORN[1] AND E. R. AMBROSE[2]

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THIS paper describes the operation and performance of a heat-pump system employing water storage and using air as the heat source. The thermodynamic principles of the heat pump, together with a discussion of the advantages and disadvantages of various heat sources and possible operating cycles, have been purposely omitted by the authors since it was felt that this phase of the subject has been adequately treated elsewhere.

The use of storage for supplementing daily output to meet peak demand has long been used in the commercial refrigeration and electric-heating field. However, the use of storage in the comfort-air-conditioning field has only been employed to a very limited extent. This is somewhat surprising since air-conditioning equipment, without storage, has less than 50 per cent average operating time because of the wide fluctuation in climatic conditions.

An electric load such as summer air conditioning, having a high demand factor and a low power consumption per unit of capacity, does not favor a low electrical-energy cost. This is particularly true if the added load makes no improvement in the system load characteristic. Generally, commercial summer air conditioning, as well as residential heating and cooling, have been observed to have closely the same shape as customers' other electrical loads, resulting in an additive load coming directly on system peaks. Also, it has been noticed that the summer air-conditioning load is one of the contributing factors for the shifting of the annual peak from winter to summer on a number of the utilities' systems.

Storage offers a practical method of making the air-conditioning load more attractive to the utility and more economical to the customer because not only is it possible to reduce the magnitude of the maximum load by using equipment of smaller capacity operating for longer periods, but the time of occurrence can also be controlled. In this way the air-conditioning load may be shaped over a 24-hr period in such a manner that, when combined with lighting, electric ranges, electric hot-water heaters, and other commercial and residential loads, the total maximum demand for all requirements is materially reduced. In fact, in many cases it may be found possible to suitably size and arrange the storage during both the heating and cooling cycle so as to require comparatively little in the way of additional power facilities for the air-conditioning load.

Storage can be used with almost any type of heating and cooling systems, but it appears to be particularly adapted to a heat-pump system using air as the heat source. The chief disadvantages of air as the heat source are: (1) As the outdoor-air temperature drops, the heating demand of the structure increases, and the output of the heat-pump equipment decreases; (2) as the outdoor temperature falls below 32 F, frosting of the heat-absorbing coil is a possibility. Storage seems to be an ideal combination with an air system, because during the heating cycle and cooling cycle it is possible to store hot or cold water during mild weather for use when extreme temperatures are being experienced. Also, with this type of system, defrosting can be simultaneous with the heating of the conditioned space. Since the storage tank can be charged in mild weather for use as a booster during extremely cold or warm days, it is possible to size the compressor and other equipment to have an output substantially less than that required for extremely low or high outdoor temperatures. This possibility not only allows use of a smaller compressor and other refrigeration equipment to satisfy the conditioner space year round, but also results in a higher coefficient of performance, since charging the tank can take place when outdoor temperatures are most favorable.

A description of the heat-pump system in the control building of the Tidd Plant of The Ohio Power Company at Brilliant, Ohio, should be of interest because air is the heat source, water storage is employed, and the system is located in a section of the country which experiences wide fluctuations in outdoor temperatures.

DETAILS OF BUILDING

The control building of the Tidd Plant, erected in 1946, has one story with a partial basement. The structure is 82 ft long × 52 ft wide × 12.2 ft average height, with a total volume to to be conditioned of 52,000 cu ft.

The construction consists of reinforced-concrete foundations and floor with precast-concrete plank roof supported on steel beams, which rest in the masonry walls. The roof is insulated with 2-in-thick rigid insulation set in pitch on the outside of the roof deck which in turn is covered with a twenty-year tar-and-gravel roof.

The walls consist of 8 in. of brick with 4 in. of glazed tile on the interior. The ceilings are furred and plastered and the floors are covered with asphalt-tile flooring.

Fig. 1 is a west view of the control building showing the main entrance. Fig. 2 is an isometric view of the heat pump located in the partial basement. The outdoor air coil, fan, and enclosure are in the foreground, the compressor, conditioner unit, and supply duct are in the background to the right; the filter, storage tank, and circulating pump are to the left.

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Contributed by the Power Division and presented at the Spring Meeting, Tulsa, Okla., March 2–5, 1947, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

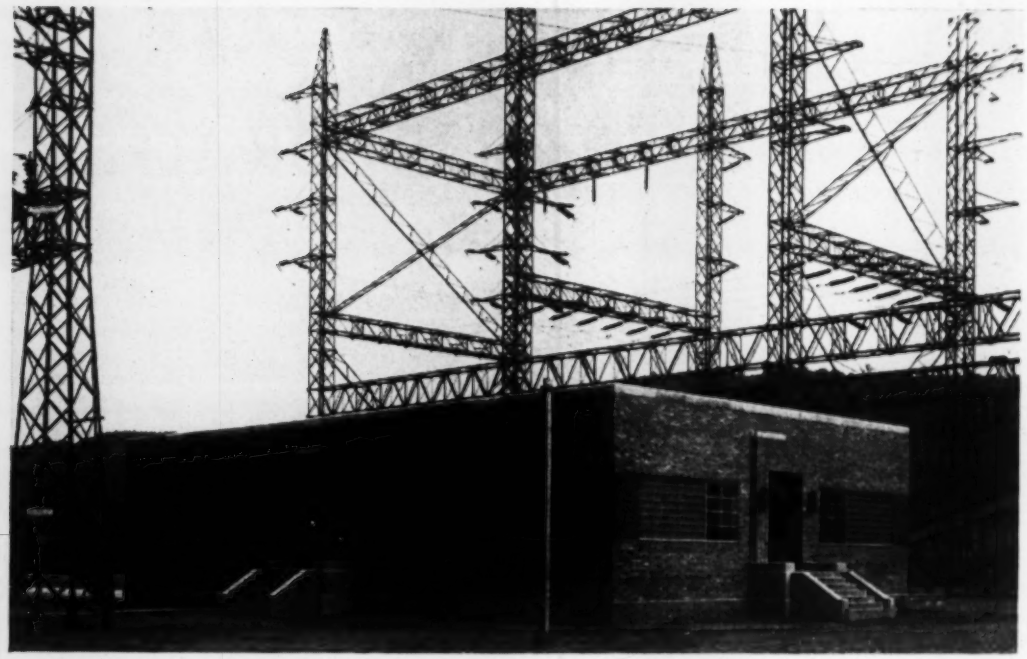

FIG. 1 CONTROL BUILDING OF THE TIDD PLANT, BRILLIANT, OHIO

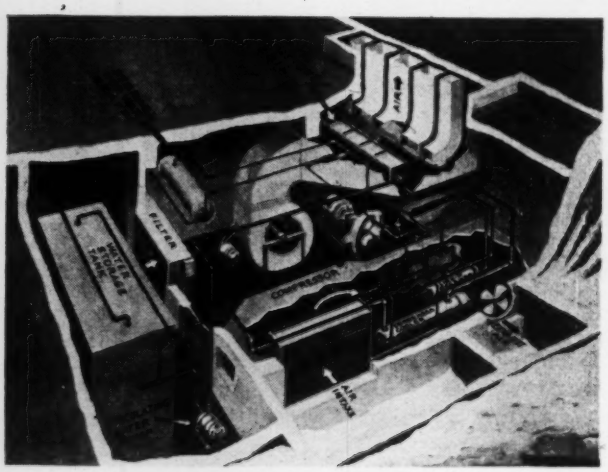

FIG. 2 ISOMETRIC VIEW OF HEAT PUMP

CAPACITY REQUIREMENTS

Climatological data, giving the daily minimum and maximum temperatures, are published by the United States Department of Commerce Weather Bureau for most regions of the United States. These data were studied for the past several years for Steubenville, Ohio (closest weather station to Brilliant, Ohio), to determine the probable minimum and maximum temperatures which would be encountered during the heating and cooling seasons at Brilliant. From these data, the 1942–1943 season was selected and plotted in the form shown in Fig. 3. Using Fig. 3, the heating season is represented by the period from October 1 to May 1, and the cooling season by May 1 to October 1. The heat-loss calculations for the structure were based on an outdoor temperature of 0 F and an indoor temperature of 70 F, and the heat-gain calculations on outdoor temperatures of 92 F dry bulb and 72 F wet bulb, and indoor temperatures of 78 F DB and 65 F WB. Using these design temperatures, the heat loss was calculated to be 200,000 Btu per hr and the heat gain 164,850 Btu per hr. The breakdown of these totals is given in Table 1.

TABLE 1 HEAT GAIN - HEAT LOSS CALCULATION

	Heat gain, Btu per hr 78 F DB and 65 F WB inside 92 F DB and 72 F WB outside	Heat loss, Btu per hr 70 F DB inside 0 F DB outside
Sensible heat:		
Conduction and solar radiation	78654	168700
Lights	47200	
Ventilation air	22800	31300
People	900	
Latent heat:		
Ventilation air	14000	
People	1296	
Total	164850	200000

Based on the temperature given in Fig. 3, + 22.3 F was chosen as the equipment design temperature during the heating cycle and 92 F DB with a corresponding 72 F WB for the cooling cycle. It can be noticed from Fig. 3, there is a possibility that the average daily dry-bulb temperature will drop below the equipment design temperature of 22.3 F on a portion of 22 days during the heating season. Of this total, 6 days are 20 F or above, 7 between 17 and 20 F, and the remaining 9 days between $3\frac{1}{2}$ and 15 F. During the cooling cycle, referring to Fig. 3, the daily average dry-bulb temperature does not exceed the 92 F selected equipment design temperature in the particular year chosen; consequently, if the equipment satisfies the heating requirement there will be no particular problem during the cooling cycle.

A storage tank, plus an auxiliary electric heater, are incorporated in the heat-pump system to furnish the additional heat required for the structure on the days having an average daily temperature below 22.3 F.

WATER-STORAGE TANK

A study of Fig. 3, shows that the daily average temperature

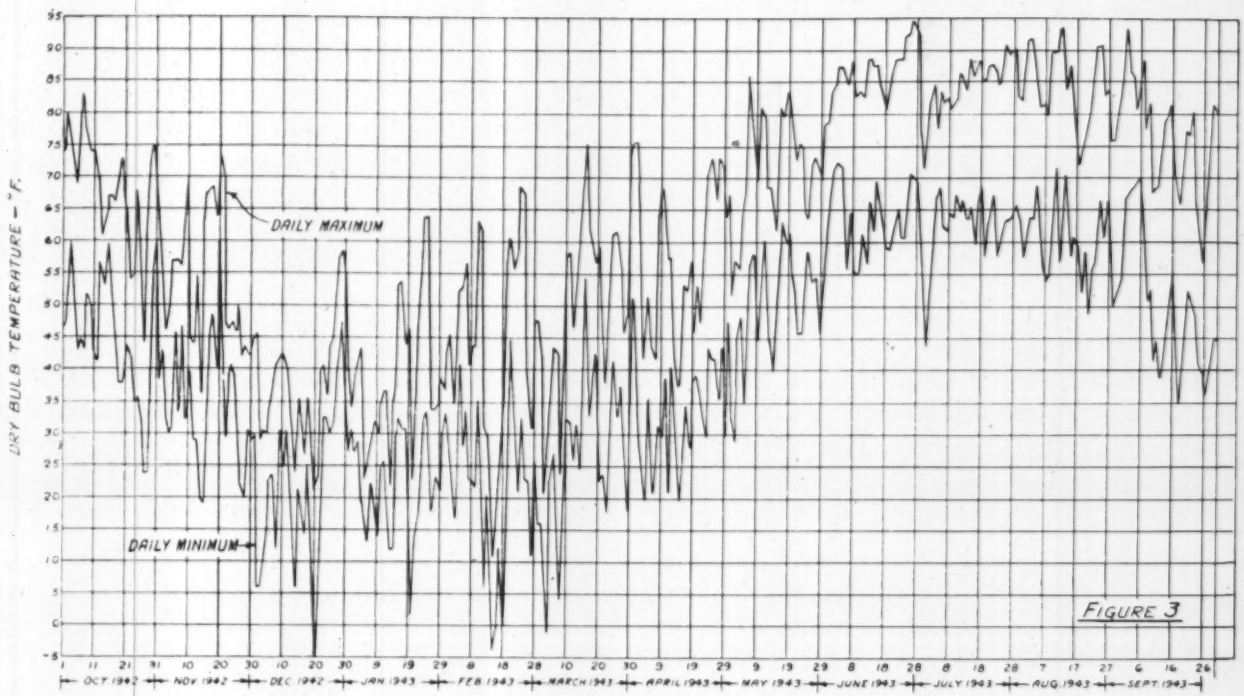

FIG. 3 DAILY MINIMUM AND MAXIMUM TEMPERATURES DURING 1942–1943 FOR STEUBENVILLE, OHIO

of 15 F, experienced on December 14, and the temperature of $14^1/_2$ and $8^1/_2$ F, experienced on December 20 and 21, respectively, are preceded by several days of daily average temperatures above 22.3 F. Likewise, the $14^1/_2$ F experienced on March 3 and 14 F on March 4, are preceded by several warmer days to permit charging the tank sufficiently to take care of the added heat requirement of the structure above that supplied by the heat-pump equipment. However, the 12 F on February 14, the $3^1/_2$ F on February 15, and the $8^1/_2$ F on February 16 do not allow any time for the charging of the tank. Consequently, the storage tank, plus the auxiliary heater, must be of sufficient size and capacity to furnish the additional heat required during this 3-day period. If this period is satisfied, the additional heat required for any of the other periods mentioned, can easily be met.

Fig. 4 shows the heat loss of the structure and the heating capacity of the heat-pump equipment at various outdoor temperatures. It can be noticed that the heat-pump balances the heat loss at outdoor temperature of 22.3 F, selected from a study of Fig. 3. Below this temperature of 22.3 F, the heat-pump equipment has insufficient capacity to meet the heating requirements, and above this point the heat pump is capable of supplying considerable excess capacity. The purpose of the storage tank, during the heating cycle, is to furnish the heat requirements during those days when the capacity of the heat pump is insufficient. The storage tank is charged with warm water by the heat-pump equipment during the periods when excess capacity exists over and above that required for heating the structure.

The heat-pump output and the structure heat loss, on the three days chosen as a basis for the storage tank, can be obtained from Fig. 4 and tabulated in the form given by Table 2.

Heating for a 24-hr period would require a total of 24 × 236,000 = 5,660,000 Btu additional heating capacity. In obtaining this figure, the storage and thermal flywheel action of the structure was not considered nor was the internal heat gain, including lights, people, and sun effect, taken into account.

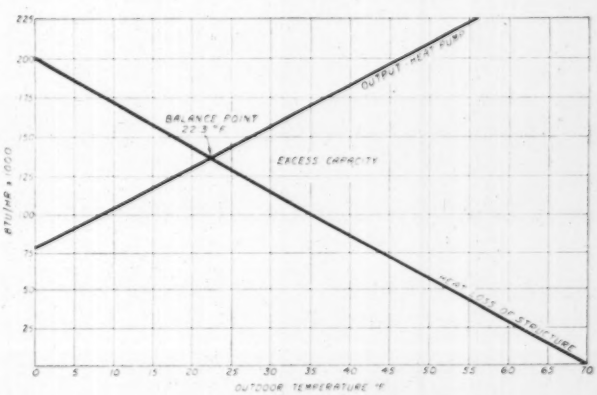

FIG. 4 HEAT LOSS OF STRUCTURE AND HEATING CAPACITY OF HEAT-PUMP EQUIPMENT

TABLE 2 HEAT-PUMP OUTPUT AND STRUCTURE HEAT LOSS ON THREE LOW-TEMPERATURE DAYS

Date	Daily avg temp, deg F	Structure heat loss, Btu per hr	Capacity heat pump, Btu per hr	Additional capacity required, Btu per hr
Feb. 14, '43	12	165000	107000	58000
Feb. 15, '43	$3^1/_2$	190000	87000	103000
Feb. 16, '43	$8^1/_2$	175000	100000	75000
Total		530000	294000	236000

Also the quantity of ventilation air, used in the heat-loss calculation, is approximately twice what would be obtained by natural infiltration and probably could be considerably reduced during the extremely cold days without ill effect. If the ventilation air is reduced 50 per cent, it would reduce the additional heating capacity required by 2,000,000 Btu. The extent to which the storage and thermal flywheel effect of the structure

and the internal-heat gain will influence the estimated additional heat required is a matter of individual judgment. Based on our experience with similar installations, the heat required at the extreme temperature will be considerably below that indicated by the conventional heat-loss-calculation method. Just how much or how little depends on a number of factors, such as size, type of construction, usage, size and type of windows, amount of insulation used, etc. Taking all these factors into consideration and keeping in mind that the occurrence of three similar days of extreme temperatures is very infrequent, a 384-cu ft storage tank was selected which will supply 1,920,000 Btu additional heating based upon an 80 F temperature range. The controls are so adjusted that the heat pump will raise the water to 120 F, and a 15-kw electric-resistance heater will raise the temperature from 120 to 160 F or 180 F as required.

DESCRIPTION OF SYSTEM

The conditioned air is distributed to the several zones of the building by means of galvanized-iron ducts. The air is returned through grilles, located in the outside walls near the floor (usually underneath the windows), which connect to a horizontal duct below the floor by means of wall chases.

A blow-through type conditioner unit is employed. In this design, the conditioner fan delivers the outside-recirculated air mixture through the filters, then over the conditioner coil, or through the by-pass into one of two plenums. The zone thermostats, by controlling the operation of the two dampers located in the plenums, regulate the temperature of the supply air.

The unit used to absorb the heat from the outdoor air consists of a coil, fan, and housing. During the heating cycle, the air is taken in from the outside, over the coil where heat is given up to the refrigerant, then discharged by the fan back to the outside. During the cooling cycle, or during the defrosting cycle, the outdoor coil is used as an air-cooled condenser.

REFRIGERANT AND WATER PIPING

Fig. 5 is a schematic diagram of the refrigerant and water piping of the heat-pump system using water storage. During the heating cycle, valves 1, 2, 3, and 4 are opened and 5, 6, 7, and 8 are closed. Compressed refrigerant gas passes through the refrigerant-water heat exchanger to the coils of the condenser-cooler where it is condensed, giving up the latent heat of condensation to the circulating water. The condensed refrigerant passes on to the liquid receiver, then through the heat exchanger, expansion valve, and outdoor coil, where heat is absorbed from the outdoor air. From the outdoor coil, the refrigerant goes through the liquid-gas heat exchanger and then returns to the compressor.

During the cooling cycle, valves 1, 2, 3, and 4 are closed and valves 5, 6, 7, and 8 are opened. Compressed refrigerant gas passes through the refrigerant-water heat exchanger to the outdoor-air coil, where it is condensed, giving up its latent heat of condensation to the outdoor air. The condensed refrigerant passes on to the liquid receiver, the heat exchanger, then through the expansion valve to the coil of the condenser cooler where the heat of vaporization is absorbed from the circulating water. From the condenser cooler, the refrigerant gas goes through the liquid-gas heat exchanger and then returns to the compressor.

During the defrosting cycle, the path of the refrigerant is the same as the cooling cycle, going first to the outdoor-air coil, then on to the liquid receiver and heat exchanger, through the expansion valve to the condenser cooler, then back to the compressor. The high temperature - high pressure refrigerant gas from the compressor passes through a heat exchanger in going to the condenser cooler during the heating cycle, or to the outdoor coil during the cooling cycle. This heat exchanger is in the domestic hot-water circuit. In this manner the refrigerant gas is used to heat the water used for domestic purposes in the building.

Circulation of the water by the pump from the condenser cooler and/or storage tank, through the conditioner coil in a closed circuit, is the same during the heating, cooling, and defrosting cycles. The only difference is that, during the heating cycle, hot water is circulated, and, during the cooling cycle, cold water is circulated.

The electric-control diagram for the operation of the heat pump system is shown in Fig. 6. After manual switch No. 1 is closed, starting the conditioner supply fan, the system is completely automatic year round.

HEATING—DAY CYCLE

When the outdoor-recirculated air temperatures drop below the setting of ductstat S-1, the system is positioned to the heating cycle by opening valves V-1, 2, 3, and 4, and by energizing relay coil and closing contacts R-4. The closing of contacts R-4 operates the water-circulating pump and allows immersionstat S-2, located in the discharge of the condenser cooler, to control the supply of the hot water for the conditioner coil by operating the compressor motor and the 5-hp outdoor-air fan motor.

Immersionstat S-3, set approximately 3 deg F lower than S-2, controls the operation of 3-way valve V-9 to allow the use of the higher-temperature water from the storage tank when the refrigerating compressor is unable to maintain the desired water temperature to the conditioner coils.

The zone heating thermostats T-1, 2, 3, and 4, will control the

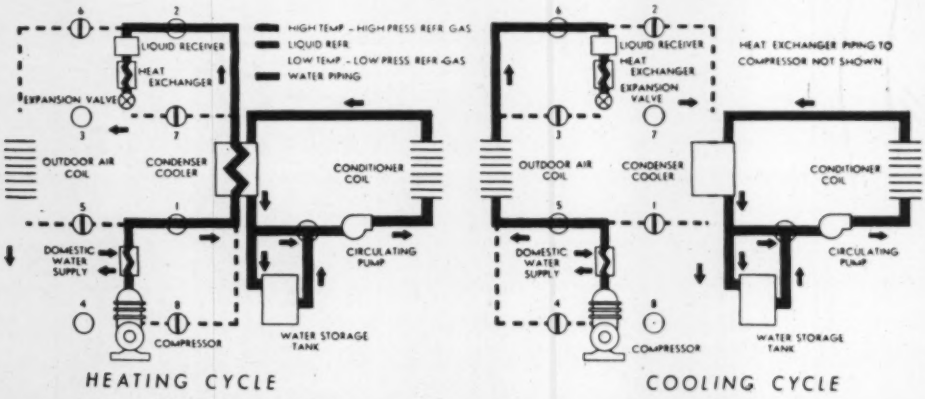

FIG. 5 SCHEMATIC DIAGRAM OF REFRIGERANT AND WATER PIPING OF HEAT-PUMP SYSTEM USING WATER STORAGE

operation of their respective damper motors. These controllers will be in operation on a call for heat by S-1.

Clock switch No. 1 will control automatically the defrosting of the outdoor-air coil. When the outdoor-air temperature is lower than the 35 F setting of S-4 and the clock switch contacts are closed, the relay coil R-2 will be energized to stop the out-

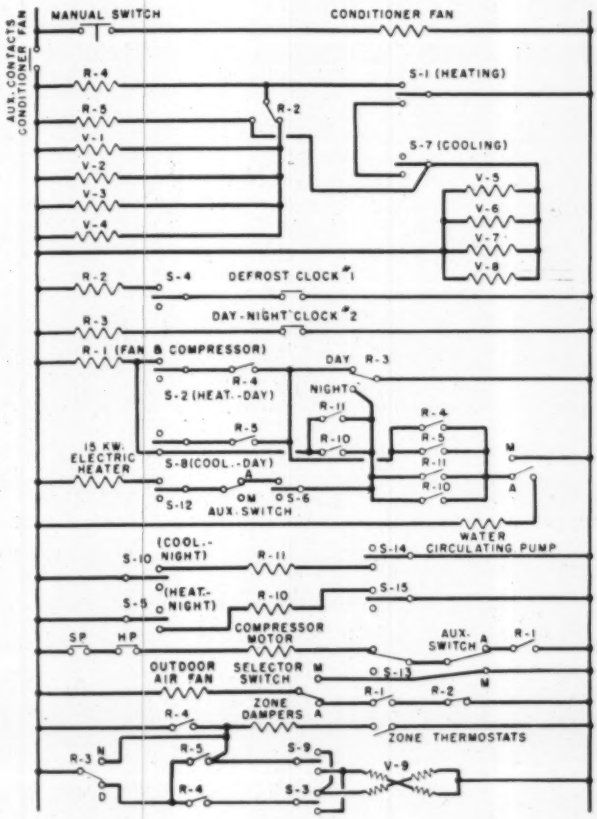

FIG. 6 ELECTRIC-CONTROL DIAGRAM FOR SYSTEM

door-air fan, close valves V-1, 2, 3, and 4, and open valves V-5, 6, 7, and 8.

COOLING—DAY CYCLE

When the outdoor-recirculated air temperature rises above the setting of ductstat S-7, the system is positioned to the cooling cycle by opening valves V-5, 6, 7, and 8, and by energizing relay coil and closing contacts on R-5. The closing of contacts R-5 operates the water-circulating pump and allows immersionstat S-8, located in the discharge of the condenser cooler, to control the supply of cold water for the air-conditioner coil by operating the 15-hp refrigerating compressor motor and the 5-hp outdoor-air fan motor.

Immersionstat S-9, set approximately 3 deg F higher than S-8 controls the operation of 3-way valve V-9 to allow the use of lower-temperature water from the storage tank when the refrigerating compressor is unable to maintain the desired water temperature to the conditioner coils.

The zone-cooling thermostats T-6, 7, 8, and 9, will control the operation of their respective damper motors. These controllers will be in operation on a call for cooling from S-7.

When the outdoor temperature is below the setting of ductstat S-15 during the heating cycle, or above the setting of S-14 during the cooling cycle, the storage tank will be charged with warm or cold water under control of S-5 or S-10.

TABLE 3 TYPICAL PERFORMANCE DATA FOR TIDD HEAT-PUMP SYSTEM[a]

Conditioner coil:	
Air circuit:	
Cubic feet per minute	10750
Entering temperature, deg F	67.5
Leaving temperature, deg F	80.0
Water circuit:	
Gallons per minute	47.0
Entering temperature, deg F	88.2
Leaving temperature, deg F	82.0
Outdoor coil:	
Air circuit:	
Cubic feet per minute	14850
Entering temperature, deg F	30.0
Leaving temperature, deg F	21.8
Condenser-cooler:	
Water circuit:	
Gallons per minute	47.0
Entering temperature, deg F	82.0
Leaving temperature, deg F	88.2
Electric consumption, kw:	
Compressor motor, 15 hp	11.70
Water-circulating-pump motor, 3/4 hp	0.51
Conditioner fan motor, 7 1/2 hp	4.49
Outdoor fan motor, 5 hp	3.27
Compressor:	
Head pressure, (98 F) psi	114
Suction pressure, (19 F) psi	19
Refrigerant effect (including liquid subcooling), Btu per hr	120000
Heat output total, Btu per hr	156000
Coefficient of performance:	
Using kilowatt input to compressor	4.02
Using total kilowatt input (except conditioner fan motor)[b]	2.93

[a] During heating cycle on 30 F day.

[b] Sixty per cent of kw input to water circulating pump included as useful work.

PERFORMANCE

Table 3 gives the typical performance data for the heat-pump system when operating on the heating cycle at an outdoor temperature of 30 F. The storage tank was not being used when these data were taken. Because of the difficulty of measuring the heat supplied to the domestic hot water, this was not segregated from the heat supplied for building heating. The data given in Table 3 cover the first of several performance tests which will be made on this heat-pump system to determine its performance under various operating conditions, and to determine what changes can be made to improve its operating efficiency.

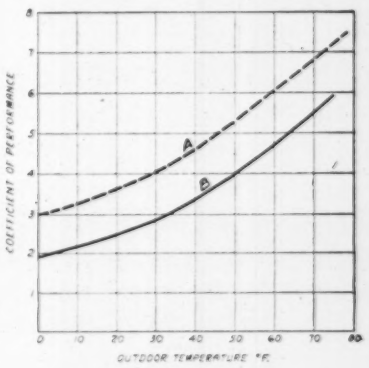

FIG. 7 PERFORMANCE CURVES

The data in Table 3 were used, together with manufacturer's compressor and coil performance data, to estimate the coefficient of performance at various outdoor temperatures, as given in Fig. 7. It must be kept in mind that this figure represents only the estimated coefficient of performance based upon one performance test and is subject to revision when additional tests are made. Table 3 gives a compressor condensing temperature of 98 F, which may be used for outdoor temperature of 30 F and lower. Above 30 F outdoor temperature it is believed a 90 F condensing temperature will be satisfactory, which will raise the coefficient of performance figures given in Fig. 7.

(*Continued on page 921*)

The JUNIOR EXECUTIVE'S PLACE *in* PRODUCTION

By J. T. BROWN

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THE size of an organization and the type of manufacturing in which it is engaged are important factors to be considered in approaching the problem of the junior executive's place in increasing productivity. The author's experience has been with a company engaged in the general metalworking industry with a widely diversified line of products—a considerable number of which are made almost on a job-order basis and others which are standardized and repetitive, but very few of which reach into the field of what might be called mass-production operations. We currently employ approximately 2000 people at one location in Milwaukee and about 800 people evenly divided between two plants, at Springfield and Worcester, Mass. Two of these plants employ union labor, represented by locals in the United Steelworkers of America. In the other plant no union organization is involved. The two union plants do not have any form of compulsory unionism; such as maintenance of membership, checkoff, and the like.

PROBLEMS OF PRODUCTION

Production in a given manufacturing enterprise is dependent upon a great many factors, of which the following are most vital: (1) Adequate plant and equipment; (2) modern methods and tooling; (3) adequate supplies of raw materials; (4) adequate manpower with a desire to produce; and (5) the proper co-ordination, direction, and management of the first four items. This paper will be concerned principally with the last two items.

The responsibilities of the management of a business enterprise are discharged through the various individuals who make up what may be called the supervisors' organization. The term "junior executive" is subject to many different interpretations. For purposes of this paper, the term "supervision" and "supervisory personnel" will be used instead, since they describe to better advantage the kind of an individual to which reference will be made. These men are junior executives in that they carry executive responsibility in their individual functions and yet they are not at the top level of management. On the other hand, they are not necessarily juniors in so far as their age distribution is concerned.

One of the greatest problems in obtaining proper production is that of creating the desire throughout an organization to produce. Today management is faced with the problem of how to get the machinery of production running smoothly and efficiently. While there are many things which have to be overcome in the way of material shortages, equipment shortages, and the like, the major problem and the most difficult one to solve has to do with the human beings who constitute the most important part of our production potential. There probably was never a time when so many people apparently have lost interest in their work. They seem to have lost pride in their performance and no longer have the will to do their best. This problem is difficult of solution because it is an intangible one. It is hard to understand, since it is caused by a state of mind rather than by any physical or material shortcomings. It is a problem of character and ethics, and is spiritual in its nature rather than technical.

Management has to solve this problem. Management consists of nothing more than the collective efforts of a supervisory group. Therefore, we must face squarely the fact that it is no longer enough to have our supervisory force adequately trained from a technical standpoint and properly instructed so it can direct the work and operations of production. It is necessary that supervisors become leaders of men. They must be capable of developing confidence in themselves and in their organization. They must be able to influence and to correct the thinking among the employees so as to create within an organization the desire and the will to accomplish its objectives.

This problem cannot be dropped in the laps of supervisors or junior executives and allowed to rest there. It is a problem which must be faced by all levels of management. It cannot be solved by top management and senior executives without the complete support and help of all supervisors and junior executives. Unless we can create from the top management down a policy structure and an organization philosophy that are sound, we cannot hope to solve our problem. It is absolutely necessary that we get back to the fundamental principles, and we must attempt to do things the right way rather than the expedient way. We cannot condone make-work provisions, feather-bedding, restrictions in output, and other unsound practices without paying the penalty for them. We must build character into our business organizations—try to give them a personality and a philosophy; and this must be consistently and carefully done. Furthermore, it must extend all the way down and include everybody who works in our enterprises. To do this will require leadership on the part of everyone who is in a supervisory capacity, and we must equip our supervisory force with the knowledge and information necessary to do the job. They must be in a position to combat false ideologies. They must be able to combat the unsound economic thinking which is constantly being fed the public.

QUALIFICATIONS FOR SUPERVISORS

The supervisor must have the right atmosphere, the right policy structure, and the right training, but above all he has to be the right kind of a person with ability to do his part of the job. Under today's conditions, this is no easy task. Generally speaking, industry is more complex in its operation than it has ever been. This in itself makes a supervisor's job a more comprehensive one. Probably the most important qualification for any supervisor or junior executive to have is the ability to handle correctly and fairly the people who work under his supervision. Next in importance is for him to be able to discharge his own responsibilities so that they meet the requirements laid down by those under whose supervision he works. He must be able to discharge his responsibilities in complete cooperation with the other members of the supervisory organization who are on his same level of authority and whose work

Contributed by the Management Division and presented at the Semi-Annual Meeting, Chicago, Ill., June 16–19, 1947, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

and responsibilities are related to the same general objectives. He must understand his responsibilities and authority. Finally, he must have sufficient technical knowledge and know-how to supervise and direct properly the work of those under his supervision.

It should be pointed out how tremendously important is the supervisor's or executive's responsibility in his dealings with other individuals, either those who are under his direction, or those for whom he works, or his relationship to others on the same level as himself. We cannot fail to appreciate and recognize the importance of the technical abilities of our supervisors and executives. However, in themselves, these technical abilities are not sufficient. In the past, too much emphasis has been placed upon them rather than upon the human-relations aspects which are involved in the problems to be met and solved. Part of this is a matter of education, and it is gratifying to note that many of our colleges and secondary schools are beginning to study and attack this problem.

Unquestionably, industry and business have been delinquent in this respect. We have pleaded with and urged our educational institutions to give us more highly trained technical men and to include vocational work in their curricula.

This is salutary in itself; but, in urging these requisites for industrial training upon educators, too often we have neglected to emphasize that the character-building subjects, the humanities, and the instruction in those things which tend to develop high moral standards, sound ethical standards, acceptance of responsibilities, and the like, cannot be neglected. It is the author's opinion that, if any sacrifice in our educational process must be made because of time limitations, it will be far better to relax the technical requirements than those of human relations and character. Many of the technical requirements of his job may be studied under the guidance of industry itself, but unless, by the time he leaves college, the individual has developed high standards of character, a sense of responsibility, the habit of sound moral and economic thinking, it is difficult for him to acquire these qualities after he enters into his business activity.

BASIC POLICY—WAGES

The following is an illustration of what is meant by the importance of having a sound basic policy, of having it thoroughly understood, and of having the supervisory force trained so that it may be administered properly. Today, one of the most controversial and difficult problems with which a business enterprise must contend is the matter of wages. Therefore, any given business organization must have a wage policy. This wage policy must be sound. It must be followed consistently and understood both by junior executives and by senior executives. What is more, there can be only one wage policy within an organization. We cannot have three or four wage policies and hope to be successful. It is not only impractical, but basically wrong, to have different wage policies in different departments within the same plant. Hence, it is perfectly obvious that each supervisor cannot have his own wage policy. He can influence, and it is important that he help formulate and have a voice in establishing the general wage policy. Once this policy is established, then it is the responsibility of everyone in the supervisory force to carry it out and make it work.

In order to make a wage policy function successfully, supervisors not only must believe in it but also understand it; and they have to be able to sell it. They have to know its strength and its weaknesses. They have to know how to apply it and administer it. Now if an organization is of any size, it will take considerable time and a lot of work to educate the supervisory organization in an understanding of this wage policy and in learning how to apply it. Therefore it should be obvious that this policy cannot be changed periodically as a matter of expediency, because if it is, no one will ever have an opportunity to make it work. This, of course, makes it extremely important that we develop a sound and workable policy to begin with. Then the management of a business must have the courage to live by the principles which it lays down.

Let us assume for a moment that we have a wage policy which is based upon compensation to the individual in accordance with merit, ability, and production. Along comes a crisis with a labor union which demands a wage structure based upon seniority. It may be expedient to compromise our principles and our policies, but if we do we must recognize that we are weakening our own position in the eyes of our supervisory personnel and in the eyes of our workmen, because our wage structure based upon merit and performance is either right or wrong as it stands. If it is right, let us stay with it. If it is wrong, we should change it.

Top management in its relations with organized union groups has not done a very good job in this respect. We have accepted as expedient many things which we sincerely know are both wrong, and unsound. In doing this, we cannot help but lose the respect of junior executives and other supervisory personnel because we cannot expect them to be zealous, diligent, and consistent in their efforts to accomplish objectives if we do not demonstrate that we have the courage to follow our own convictions and principles. We cannot demand from supervisors high productivity and low cost if we are going to be so weak as to let the pressure from organized labor cause us to agree and condone feather-bedding, work restrictions, special privileges to individuals, and other costly practices which we know are economically wrong.

We must recognize that we cannot single out a group of supervisors or junior executives and place the problem in their laps without putting the whole management house in order. We need and should expect great things from the proper kind of supervisors and junior executives, but we have to create the right environment and the right management structure which will permit them to accomplish their job. This point is emphasized simply because it is believed to be one of the elements most often overlooked in connection with the problems of today. No group of executives or of supervisors within a given management structure can be any stronger, any more effective, or any more efficient, than the management structure itself.

TRAINING THE SUPERVISORY FORCE

Again, let us assume that we have in our enterprise an able management structure, and that we have an established set of principles and policies in which we believe. Next, these principles and policies must be out where everybody can see them. We must train our supervision and junior executives in what these principles and policies mean. We have to sell them on the soundness of these principles and policies, and we have to equip them to sell the people under their direction. This is a never-ending job. The interpretation and the application of our principles and policies as they spread down through an organization are difficult to control.

After many individuals have tried to reach an understanding of these matters, which satisfies them, the original intent is sometimes hardly recognizable. Therefore we must have some means of discussing these policies with our supervisors. Practical illustrations must be given as to how these principles can be applied. No better method of accomplishing this objective is available than the conference-group type of supervisory-training program.

We want our supervisor or junior executive to be a man of in-

tegrity and high moral character. This is tremendously important and has never had the recognition that it deserves. If he is to have the confidence of the people in the organization and if he is to assume a place of leadership, strength of character is of the utmost importance.

BENEFITS OF A HIGH PRODUCTION LEVEL

Nothing is of more benefit to the general well-being of our society than high production. Most of us know that, most of us believe it, but we have to sell it. We must certainly sell it to those people who work in our business enterprises because, unless they believe that production is important and accrues to their own benefit, we will not get production. Many examples might be cited of technical advances which were designed to increase productivity but which were counterbalanced by restrictive practices which eliminated or offset the possible benefits. This is not sound economics. We must know that; we have to recognize it; and we have to be sure that our supervisory force knows and recognizes it. Then through the medium of the supervisors we may be certain that the workmen in our plants will know it and recognize it.

We cannot continue to follow so many false economic theories in this country, nor can we continue to permit the development of the idea that management and labor are antagonistic. The interests and objectives of management and labor are the same. They are not opposed to each other. It is more production per man-hour that raises the standard of living. It is not more money for less work. It is not shorter hours and more pay. It is not unemployment insurance and old-age pensions. It is not high wages. It is not government subsidies. These things do not, cannot, and will not raise the standard of living of the people in this country. The only thing that will raise the standard of living is increased productivity. If we know this, and if we believe it, then we have the obligation and responsibility to see that everybody in our business enterprise knows and understands it. It is only through better understanding of this one basic fact that we will overcome the state of mind of far too many people which has destroyed their desire to produce and to contribute to the production of goods and services. All the technological and mechanical improvements in the world will not solve our problem unless we can overcome this hurdle. If we recognize this, then we must be sure that our supervisors and junior executives also recognize this phase of their jobs in obtaining production.

THE SUPERVISOR AS A LEADER

As a leader, the supervisor and junior executive must also contribute to the building of character and in strengthening the individual's pride in his own work and in his own accomplishments. His desire to do what he does well must be strengthened. People today are subjected to so many demoralizing notions and emotional appeals that they are confused. This is liable to affect their work and in too many cases has done so. It is one of the major factors in the present industrial unrest and strife which exist in this country.

We must also watch the attempts to create a class consciousness and a class struggle between employers and employees. It undermines a man's moral character to be told constantly that he is underprivileged and that someone is taking an unfair advantage of him. It undermines character to be told constantly that the way for him to improve his own position is to tear down somebody else's position.

It should be our objective to try and build into our business enterprises a philosophy and character which will give them personality. We cannot accomplish this objective quickly, but we can devote a lot of attention to it and make progress in that direction. That is why the junior executive is so important. He is going to be a senior executive long before this job is completed.

We must combat all of the false notions and ideas which are so prevalent today. The only way we can do this is to become more articulate as individuals. We must sell sound policies and principles. We must teach them; we must understand them; we must believe in them; and we must live them.

If industrial relations is one of the most important factors in productivity, we must remember that the most important point in industrial relations is between each individual and his boss. That is the keystone to this whole problem. At any level in an industrial enterprise, management is represented to each individual through the personality of the man for whom he works whether he be president, superintendent, or foreman.

CORRECTING CURRENT ERRORS

There are many errors in thinking which must be corrected, but some of the basic ones are as follows: (1) We must overcome the idea that the way for everybody to gain greater returns is to produce less. (2) We must not have the erroneous idea that the evils existing in our present system of free enterprise are going to be corrected by the imposition and the adoption of other evil practices. We must not assume the philosophy that the end justifies the means. (3) We must rid ourselves of the notion that the way to peace, happiness, and stability in our industrial enterprise is to have a well-meaning government assume full responsibility for our security and welfare. (4) We must recognize that unless we are willing to assume responsibility for our own security, our own welfare, and our own position, we will have to surrender a great many of the freedoms, rights, and privileges which we have learned to enjoy in this country. (5) We cannot strengthen the vitality of our nation, and we cannot strengthen and improve the character of our industrial enterprises, unless we can strengthen character within individuals who make up our system. It seems so obvious that we cannot hope for any collective strength if we continue to demoralize the character of the individual.

Mechanical Engineering Research

(*Continued from page 898*)

be made with the research associations and with other organizations in the United Kingdom and with the institutions in the United States. Already Prof. A. G. Christie, past-president and honorary member of The American Society of Mechanical Engineers, when visiting Britain in connection with the Centenary Celebrations of The Institution of Mechanical Engineers, has discussed problems with some of the people concerned with the new organization, and has initiated collaboration between the two countries on matters of joint interest.

[On June 4, 1947, Professor Christie met with Dr. Guy, Dr. Hankins, and Prof. D. M. Newitt, of the Imperial College, South Kensington, to discuss the possibility of active co-operation between the Mechanical Engineering Research Organization and the A.S.M.E. (as represented by its Research Committee on Properties of Gases and Gas Mixtures, Dean John A. Goff, chairman) in a research program on thermodynamic and nonthermodynamic properties of technically important gases.

The British scientists expressed a keen desire to co-operate to the fullest possible extent and hoped that the association between the two groups could be established at an early date. They suggested that one of the first profitable steps would appear to be an agreement on methods of presentation of data, and on units, standards, abbreviations, and the like.—EDITOR.]

PROFIT SHARING *as an* INCENTIVE

By F. W. WILLEY

PRESIDENT, WILLEY-WRAY ELECTRIC COMPANY, CINCINNATI, OHIO

THE over-all history of incentive plans is not very encouraging. There have been many failures and abandonments. There are of course many outstanding successes. There can be no doubt but that the theory is sound. Faults in application are accountable for most of the past failures.

DESIRED OBJECTIVES OF INCENTIVE PLANS

The successful application of incentives will solve many problems of a social and national nature. The work effort of all of us must be pleasant. We spend half of our waking hours at our jobs. If they are pleasant hours it is likely that the other half will take care of themselves. The effort must also be profitable. It must provide for normal living costs and a margin for saving. The creation of an estate for future security and independence lies in the heart of every sound and vigorous American.

A nation of people employed pleasantly and profitably will succeed as a nation. Such a result can only come from free enterprise of which our country is so staunch a supporter. Thus, incentives promote national success and national unity. There would be internal harmony and satisfaction. It must not be forgotten that wars result from lack of harmony or dissension. The successful application of incentives conceivably could be an important factor in preventing future wars.

The religious phase must not be overlooked. True and sound incentive plans are merely the application of the principles of brotherhood expounded from our pulpits. Our present tendency is to glorify the principles one day a week and scorn them the other six days. If they are good principles, we are remiss in not using them on week days. If they are not good we are wasting our Sundays.

PRELIMINARY REQUIREMENTS

The plan must be pure in spirit. Openness, honesty, and fairness are essential. The plan should be simple and be based on sound principles. It must be understood by all participants.

Incentive shares must be proportional to the contribution of the individual to the success of the enterprise. Such contribution is usually gaged by the pay rate or total earnings. Pay rates must be carefully studied to be sure that they are relatively correct. Inequities cause trouble in themselves but are magnified by incentive payments based upon inequitable pay rates. Rate setting requires careful job analysis and individual merit rating. No incentive plan will be fully successful unless pay-rates are relatively correct. The study should include the entire personnel from president on down.

FORMS OF INCENTIVES

One group of incentives consists solely of morale builders. They do not increase the pay check. They are vacations, sick leave, hospital care, life insurance, and pensions. The second group of incentives increases the pay check. This group consists of piecework (individual or group), bonus, profit sharing, and coinvestment. Those in the first group have the nature of expense to operations. The commitments are repetitive regardless of profit or loss results. Those in the second class depend upon profitable operation.

Maybe a triple incentive would serve best, each receiving certain benefits now, others somewhat later, and the last at the end of the road. Any form of benefit paid more frequently than quarterly will generally be consumed by the recipient unless he is saving-conscious. Quarterly, semiannual, or longer-period payments are more likely to be retained for estate building.

PROFIT SHARING

Profit sharing is alluring and if properly planned and administered forms a high type of incentive. It is really financial participation which increases the dignity of the worker. It gives him a stake in the enterprise success. Human effort is the greatest factor in success and basically is entitled to adequate reward. Truly there is a moral right of sharing in the results. If, however, such right is acknowledged, human effort must also assume responsibility for and share the burden of loss. It is a poor rule that doesn't work both ways. Therefore, this top type of incentive should be renamed "profit and loss sharing." A player must not quit when the team is losing. That is not the American idea of good sportsmanship.

Fundamentals in Profit and Loss Sharing. It must be recognized that there are two basic tools in enterprise. The first is human effort. It is employed and paid a hire for its use in wages and salaries. Capital is required to provide for the use of human effort. Capital is the second tool and should be paid a fixed hire for its use as an expense to operation. When capital is borrowed from a bank, a hire is paid. The same principle should apply to the borrowed capital of the investor.

After the hire is paid for both human effort and invested capital, it seems logical to share profits by means of a uniform dividend on all dollars earned and all dollars invested. This provides a stake in the enterprise for every participant from the owner all the way down to the janitor. This encourages the much desired team spirit in the enterprise. Note that such a plan distributes the benefits according to the contribution of each to the operational success. Note also the definiteness of the formula. There are no arbitrary decisions by the stockholders or the board of directors.

The enterprise picture would be perfect if every worker were a part owner and every owner were a worker. A worker who saves should logically invest his savings. He should want to invest where he sees his money at work and has the opportunity and responsibility to make it work successfully. This suggests some form of coinvestment plan. Coinvestment adds a dignity to the worker's position.

The sense of dignity of the worker is a vital factor in incentive plans. He must realize that all forms of benefit are taken out of enterprise earnings and that he earns his share. The

Contributed by the Management Division and presented at the Semi-Annual Meeting, Chicago, Ill., June 16–19, 1947, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

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The Case Study. The foregoing treatment of the subject is not the result of idle dreaming. The incentive plan of the author's company did not develop along the recommended sequence. The development met the requirements as they presented themselves over the past 27 years.

The End Result. It is frequently advantageous to know the end result before studying the process by which it was evolved. The subject company is indeed a small institution in an industry composed almost exclusively of small units. The invested capital is but $75,000. There are only 30 employees. The 1946 sales amounted to $430,000, of which 60 per cent consisted of the sale of manufacturers' lines of equipment. The remaining 40 per cent, or $170,000, resulted from service work in the industrial electrical-equipment field. There is no separation of these two classes of sales in this report of operation.

It should be stated that there is open competition in all phases of operation. The results are not sensational, being merely sound, profitable, and pleasant. The basic principles of the profit-sharing plan are only common sense. The profit runs 10 to 12 per cent of sales, about double the national average for similar concerns in the same industry. The owner's share of the profit is approximately 30 per cent and is set by a definite formula. Probably the outstanding result is the pleasant relationship based on the over-all team spirit that the plan develops.

Along the way every participant from the owner to the janitor is sure to get a liberal education in the American free-enterprise system. Each is rewarded according to his contribution to the enterprise and knows the pattern to be followed to increase the contribution and, consequently, the reward. The plan is not in any sense a "handout." Every benefit and every increase in benefit must be truly earned.

The worker turnover is practically nil. There is reward for length of service. Though the work is not seasonal, there are provisions for stabilized employment and income through years of gain or loss. Efficiency is relatively high without any driving or policing efforts.

Certain features of the plan have encouraged saving habits, and every participant is building an estate of his own in true American fashion. Several participants have been or are in position to retire prior to the established 65-year age. This is in definite contrast with recent trends of thought of letting the Government provide for old age.

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An outstanding weakness of plans studied was that all profits were promptly distributed so that bonuses were impossible during unprofitable years. Therefore it was decided that, when the bonus dividend of partners and note holders exceeded 7 per cent, one half of the excess would be placed in a reserve for bonuses in lean years. The other half was distributed but in quarterly installments. This proved very wise. The year 1920 was very profitable and the reserve permitted a 7 per cent bonus dividend throughout the three succeeding lean years. The late 20's were likewise profitable and the new reserve again carried bonus payments for three lean years. This history repeated itself in the early 40's. Two deep depressions had been weathered even though there were years without bonuses.

In 1940 another important feature was added. Previously, bonus dividends were paid on invested moneys only. That is age-old. It was figured that human effort by all was an important investment also. The amount of investment of human effort was measured by the dollars earned. Thereafter, an interest of 7 per cent was paid on all invested money as a hire for its use. This interest was charged as an expense to the operation just as the hire (wages and salaries) for human effort was considered an expense. Then any profit remaining was paid out in a uniform dividend on every dollar invested and every dollar earned. The formula for the reserve fund was retained.

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Until 1945 wages were set in the usual haphazard way using the minimum that was acceptable to the worker. Studies of job evaluation and merit rating were started in 1943. It was realized that profit sharing based upon earnings would be inequitable if pay rates were inequitable. In reality, the inequity of rates was magnified by profit sharing. Current methods of job evaluation and merit rating were examined but not deemed satisfactory. Methods were created according to our own ideas and were put into effect early in 1945.

Pay-rate studies showed some too low and some too high. None was cut. Fortunately, this was a period of rate increases. The highs remained pegged and the lows gradually brought to proper levels. By the end of 1946, every rate was on the line. This required 2 years of patient effort. Now every participant is paid according to his contribution to the enterprise as accurately as determinable within our current understanding. In turn the bonus shares are similarly equitable.

The last step in the development of the plan was taken on

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CONSULTING ENGINEER, GREENVILLE, S. C. MEMBER A.S.M.E.

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The author had an opportunity during the late war to observe at first hand the production possibilities provided by the smaller plants of the country, and the actual help they could render when their facilities were properly utilized. Today approximately 200,000 small plants exist, of which one half could be utilized effectively. The potential production of these plants would exceed a thousand new large plants, with attendant saving in time and expense.

The purpose of this article is to suggest to our defense-planning group that a wide use of our small industries be studied, and, if found feasible, to develop plans for their implementation into the production structure in a national emergency.

The following is quoted from a report on "Small Industrial Plants in War and Peace," made by the author to the Smaller War Plants Corporation in 1943, which is fully applicable today:

"*Role of Small Plants in War.* The mobilization of small industrial plants, for the production of war materials, was due to an act of Congress that recognized their vast potential production capacity. Congress recognized that much of this capacity was not being utilized and as a consequence many small plants would die for lack of business while large industries were growing beyond the capacity of the man-power resources and the communities in which they were located.

"Failure or lack of foresight and planning on the part of our fighting services to quickly utilize these existing facilities is beyond comprehension. Ample warning of the coming storm was given even to the layman and the citizen on the street. It was naturally assumed that those branches of the Services had carefully compiled, classified, planned, for the use in case of war, of all the productive facilities of the Nation. They stood ready, equipped and manned, and could have gone into production on short notice. Much production was delayed and vast expenditures incurred to duplicate facilities that were already in existence. No one questions that great expansion in industry was necessary to produce materials of war but it is reasonable to suppose that had existing facilities in small plants been utilized, billions in expenditures would not have been necessary and much production obtained sooner if the small existing plant had been used fully in the war program.

"The total use of these facilities was doubtless responsible for production that enabled Great Britain to carry on during its darkest hours. Their wide variety and distribution made them less vulnerable to attack *and in any postwar program of preparation and defense they should bulk largely in our plans.*"

Everyone hopes there will be no more wars, but past history and present world conditions do not hold forth much promise that wars have ceased. It is certain that we cannot escape the effects of the next one. Large plants and our great centers of industry will be prime targets. Thousands of small scattered plants will be difficult to destroy and may provide the production necessary for survival.

The necessity of marshaling America's productive facilities, and of planning for their integration and use in times of national emergency seems so obvious that everyone would suppose some such provisions have always existed. Our national defense agencies have made surveys of many plants but it is doubtful if the information collected has ever been co-ordinated in a manner to be of any real value in our war efforts. The author admires the military and fighting efficiency of our armed services; they are the best in the world. However, they are not, in his opinion, production experts, as the very nature of these organizations precludes this possibility.

Modern war depends on production, and the side with the greatest productive capacity will always be victorious if it is effectively utilized. The problem is how to obtain maximum production in the shortest possible time when emergencies occur. As production is a plant and manufacturing function, it should first come from the existing plant facilities, supplemented by new and special facilities where necessary. This sounds very simple, and in theory it is, but putting it into effect is bafflingly complex and difficult. While modern war requires almost everything that can be produced, it especially needs the co-ordinated brain and business resources to accomplish maximum production in the shortest possible time.

The nation's engineering societies can quickly supply in classified form the range of engineering talent available. The construction organizations can do likewise. The basic industries, such as metals, chemicals, and textiles, can quickly be geared to war production. But one vast element of production resources has been generally neglected, or used only to a minor extent. This includes the facilities of the many thousands of small plants which exist in America. The effective mobilization and use of this group is particularly vital, if America is ever forced to fight another war. Should another war occur, it will have to be done if we are to survive.

HOW CAN SMALL-PLANT RESOURCES BE USED?

Can America's vast small-plant resources be effectively used? The answer has been given already, but this does not mean that many great industrial expansions would not be required also. Highly specialized products require specialized plants for their fabrication and assembly. Millions of parts are required in the production processes. It is here that small plants can perform a major function if their resources are utilized.

As the late war progressed and neared its termination, thousands of small plants were producing a myriad of vital parts for the war machine, but it took nearly two years of valuable time to reach that lead. Is this time lag necessary? Cannot

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plans, procedure, and programs be prepared in advance of emergencies to utilize immediately our small facilities effectively? Probably many will say that it is not possible, and only the exigencies of war can dictate the methods necessary to get the production required.

A COMPREHENSIVE PLAN MUST BE DEVELOPED

One thing is certain—some kind of planning will be necessary if an emergency arises. It may be good or bad planning, but certainly not as good as is possible when careful study is given to it in advance. Can planning be done in advance and before the emergency arises? The following steps would seem to be obvious:

1 An up-to-date census, schedule, and location of every plant in existence; its productive facilities and equipment; its normal range and volume of production; its personnel and experience. This will be a continuing operation, requiring frequent revision to maintain up-to-date information.

2 A classification of these plants into categories of production, with estimated production to be expected from them.

3 A continuing estimate of the volume of stable supplies required, as distinguished from the highly specialized war-procurement items which will be dictated by the time and events of an emergency. Much can be determined in advance.

4 A greater peacetime utilization of small-plant facilities by our procurement agencies, instead of allocation of the bulk of it to large and specialized plants. This will doubtless be more expensive, but the resulting "know-how" would be priceless.

5 A detailed analysis of all known procurement items into component parts or subassemblies, with detailed drawings and specifications where suitable for small-plant production.

6 Small plants should be encouraged with financial aid. The formation of potential plant poolings for emergency co-operation should be undertaken.

7 A planned program for the use of each plant to determine conversion or changes necessary to make it most suitable for the production schedule required. Each plant should know how and what it should do when the emergency arises.

8 Technical information and research service should be supplied to eligible plants selected for use in emergencies.

9 New and old industrial projects which have definite defense value should receive aid and encouragement through special tax exemptions. In other words, some incentive must be provided to encourage interest and participation.

The maximum utilization of small plants would make possible the desirable objective of scattering production facilities, thus reducing the hazard of destruction to a minimum. This could be vital, and provide the difference between victory or defeat.

It will not be denied that formulation of plans to utilize small plants will be difficult of accomplishment, and, initially, more costly. The proposal will not be looked upon with favor by our procurement officers. If done effectively, it will be far less costly than other production programs of the past, if a war occurs, and may well decide whether or not our way of life is to be maintained.

It would seem to be a proper function of our new National Defense Department to establish a bureau or division to plan for the utilization of the small plants of the nation. Small plants would co-operate if shown how.

It is possible that these suggestions have been anticipated by our defense agencies; if so, the fact has been held in great secrecy, and small plants have not heard of it. Furthermore, the most careful planning will be useless if not followed when emergencies arise. When war breaks out and thousands of new individuals are called upon to direct the war effort, advance planning may be overlooked or disregarded. This would not happen if every small-plant owner knew that he had a definite job to do; he would insist on doing it.

The author's professional relationship has been principally with those industries classified as big, but also he has seen the potential value in small industries in the aggregate. It does not imply that any difference in interests is involved, rather it should be a co-operative effort in the interest of all.

Any program for the utilization of small industrial plants will be expensive. If war occurs the cost will not be considered. War demands speed and more speed, and time is a vital element for success. Congress would doubtless look with favor upon such a project in its zeal to further small industries and, at the same time, contribute to the national defense.

A program with this purpose in view requires political genius and statesmanship of the first order. It calls for assistance in the fullest measure from every segment of our industrial structure. That such assistance will be forthcoming *when the importance of the job is appreciated* by American businessmen is a foregone conclusion.

Profit Sharing as an Incentive

(Continued from page 908)

July 1, 1946. It must be remembered that all profits are distributed annually. The reserve fund may provide income for every participant during lean or loss years but sustained losses must be met somehow. It was decided to change accounting from the yearly to a quarterly basis. Should a quarter year of operation show a loss, such amount must be recovered in the succeeding quarter by a reduction of all salaries, wages, and note interest by a uniform percentage.

CONCLUSION

It should be noted that there were many steps in the development of the plan and that they were spread over a period of 27 years. Changes were not made by edict. Each was explained to all participants prior to adoption. Comments were urgently requested. Any plan will suffer if the participants do not understand it. All cards must be face up. Plans must be as simple and as simply written as possible.

Success requires that all participants know the score of operation. Financial reports must be frequent and extremely simple. They must of course be honest. The simplest form contains only four items, income, outside bills for goods and services, salaries and wages, and the resultant profit or loss. It is helpful to show what part each of the three expenses is of each dollar of sales.

It was stated at the beginning that the results have not been sensational. Moneywise the participants receive a gross of about 30 per cent more than in similar occupations. There are other advantages. There is a place to put savings. There is a team spirit in work. There is harmony and pleasure during the working hours. There is a pattern for advancement and increased earnings.

Let it be understood that even after these many years, perfection is still ahead. Even with only 30 people, it is difficult to bring every one up to a full understanding and 100 per cent co-operation. For many years and from many sources workers have been told that management is too smart and tricky and must never be trusted. Many of our current laws were written on such premises. The development of confidence is a long uphill pull and requires untold patience and simon-pure motives. There is great satisfaction when some such plan produces a sort of human fellowship while some managements are still saying "damn the help."

The CITIZEN ENGINEER—HIS JOB

By L. J. FLETCHER

DIRECTOR, TRAINING AND COMMUNITY RELATIONS, CATERPILLAR TRACTOR CO., PEORIA, ILL. MEMBER A.S.M.E.

THERE'S a "for sale" sign on the possession you prize most highly. You don't want to sell, but some super-salesmen are selling you out! Worst of all, you have to buy back what you thought you owned.

Does this sound like double talk? It isn't! There are people selling your freedom away from you—and the only way you can make sure you won't lose it is by buying it back.

What's the price? You won't believe it when I tell you. The price is something you already have. No, it isn't money. It is some of your "time." It is time you'll have to take from golf, bridge, radio, or reading. But I'll tell you this—you will be making the best investment you have ever made.

Have you ever put a value on your individual freedom of action and freedom of speech? Have you ever tried to put yourself in the place of the engineer-citizen of those countries where freedom is now lost, where the citizen is simply an instrument of the state? What would that man give for the privilege of turning back the years so that he might have a second chance—a chance to get well acquainted with his fellow citizens, to learn why they wanted a change, and finally, a chance to do something about it? What would he give to live over again that time when misunderstanding was spreading in his community and groups were forming, each with its own interests which it considered to be antagonistic to those of other groups? What would that man give in his time for this second chance?

In relation to the situation which exists in this country today, be assured that the engineer's number-one job is still that of serving society through the application of engineering principles and developments. However, we must consider the social health of this country while we serve so well its physical needs. Are we sowing the splendid seed of fine engineering contributions on a seedbed becoming increasingly dry, hard, and unproductive? We know that our work is "good seed" in any society, but we must assume some responsibility for the condition of the seedbed.

In common with many other engineers, I have worked in totalitarian countries and have observed that the engineer is the real victim of planned economy. Those in high places are usually uninformed as to details of production or engineering accomplishments. Yet they establish quotas, appoint those responsible for meeting them, and exact without emotion the penalty for failure. The engineer under planned economy is "in the doghouse" with no back door.

LET'S ADD UP THE SCORE

There are many among us who can well remember the time when everyone was proud of our technical accomplishments in this country, when any group would respond with enthusiasm when reminded of the great strides we had taken in providing those things which contributed to better living. But the response was still greater when attention was called to the opportunities afforded every young man to go as far as his initiative and ability would carry him. We had confidence in ourselves and in the future. Try this theme today before the college class in social science or a public forum. Don't answer unless you have tried it.

Luncheon Address at the Semi-Annual Meeting, Chicago, Ill., June 16–19, 1947, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

I learned a trade and later went to college during the period of 1909–1915. Those are the days of which I am speaking. If something appeared wrong in our social or political setup, the general attitude was "let's fix it up; let's correct it; let's keep improving this splendid structure which has been so wisely and firmly building in this country for a hundred and fifty years." Those were the years of balance between the great segments of our society. Then it was generally considered that the results of our hours of work were exchanged with others with equality.

Then slowly the change started, like a disease which comes so gradually it is not noticed for years. The first world war brought great destruction and we struggled to avoid paying the cost. Our refusal to face facts may have been the first quick push down the treacherous slopes of misunderstanding.

In Russia a plague broke out. It started with the revolution against the weak and undemocratic government of the czars. Remember, the Russian revolution of the spring of 1917 was not for communism, it was for democracy. But in the fall of that year there was injected into the seedbed of tumult and war misery of Russia a new concept. It approved and promoted a slavelike relation of the individual to his government and was so completely foreign to the thinking of this country that few here could then comprehend its true significance. Fuzzy governmental theories, incubated for seventy years in the sores of European society, were suddenly enforced on a helpless people who, under wise leadership, *could* have been guided into becoming a great constructive force in world democracy.

There followed here a decade of governmental promises. A new national sport was established—it was dodging facts. A new philosophy developed, and it was based on the slow crumbling away of our basic principles and moralities which everyone felt were a part of the very soul of this nation. We tried many social narcotics and cures, some were good and some were bad. During this period there was a steady growth of those good things which have continually added to our national pattern, but the bad came in the same gate, frequently clutching the hand of the good.

Then came the second world war. The industrial and technical leaders of this country, who had been so greatly discredited in the years before the war, were quickly urged to take over and do what they could to stem the tide of the Nazi onslaught. People forgot overnight the things that had been said about the social disservice of our vast industrial organizations. The plea was for more and quicker production of war materiel. Without stopping for one word of "I told you so," these men of management sprang into every phase of civilian and military activities of this country. It has been calculated accurately that of all war materiel used by both sides in this war, 45 per cent of the total was produced in the United States of America. Russian soldiers were transported in American-built trucks, ate American food, utilized lavishly the products of our farms and factories.

With the war's end there came a change. After the crisis, for some strange reason, people were again advised to distrust our business leaders. These advisers, the prophets of gloom, most inaccurately predicted that the selfish hand of industrial management would produce mass unemployment, and pressure groups urged that the paralyzing hand of Government should

remain on the controls. But the core of this country is sound. The vast majority of men and women who work in our factories and fields want to be right, are honest and just; though, being human, may be misled for a while. We had listened to and still hear the overamplified voices of those few who are fanning the fires of distrust, strife, and misunderstanding. Believe me, these crusaders to the left spend their time doing their job. We need crusaders for sound thinking and honest living.

In this postwar situation, we underestimated the gigantic task of the reconstruction of the minds of people, saw mainly the rebuilding of homes, roads, and factories. We saw the pictures of bombed cities, but pictures of men's thinking are hard to capture.

HOW DID WE GET THIS WAY?

Now is the time to take stock, to ask ourselves why the great production and wide distribution of the products of our free economy are not ample proof of its service.

Could it be that we are "so close to the woods that we don't see the trees?" Do you realize that for the individual the mechanics of living is today the simplest of all the ages? His house is lighted but he has no knowledge of how. He simply presses the button. His house is heated; another button. Clothes, processed foods, transportation, marvelous developments in medicine and other fields are provided by specialists. Each of our ancestors had to possess broad knowledge and many skills in order to carry on the great variety of jobs required for everyday living. Today, each does his own special job for the many others and in turn receives their help. So this is the age in which the mechanics of living are simple but the understanding of living is the most complex of all history. This highly complex yet wonderfully self-articulated society of ours has come into being at such a rapid rate that people have failed to understand how it serves. Many have become the victims of those who arouse distrust and break down the cement of confidence and respect which must bind any free society.

Let's examine some of the ways people have reacted to this quick change in our way of living. It is of course natural that specialists should meet together, read each other's writings, and largely build their life about their specialty. As engineers we do it. But this has created a disease which I call "groupitis." What portion of your time is spent with people interested in things other than engineering? How often do you listen to those who disagree with your views on social, political, or economic matters? Have you learned to swap ideas without emotion? Have you found that you can develop real friendships with those who may hold certain views contrary to yours?

We are losing our sense of right and wrong, our desire for fair play, and more and more coming to believe those things we want to believe. Is there not a warning in our experience of over a year ago when much of the public accepted without question the unsupported statement that all wages could be increased 30 per cent with no justified increase in prices? No one can be blamed for hoping this might be true although all know now that it could not. Then no group or individual could gain the ear of the public when they asked, "How are we going to do it?"

In years past, through increased investment from our savings, we have provided improved machines, we have developed better methods, both resulting in more production per hour. This provides a "real" increase in wages, because it makes more and better things available for less money spent in production. It really improves our standard of living. Was the attention of wage earners universally directed toward the acceptance of this truth, that more efficient methods and greater production earned this increase? No! The public was told that such wage increases could come from reducing "swollen profits." Then followed a confusing barrage of percentage increases in the income of our huge corporations. If all the net income or profits of all our businesses were used for wages, if those who supply the buildings, machines, and materials employed in industry receive no "rent," not even one third of a 30 per cent general increase in wages could thus be met. The house-to-house salesman who makes but 25 cents one day and $2.50 the next has enjoyed a 900 per cent increase in his income but even so he is not yet a good prospect for a "Cadillac."

In a country as vast as ours, exceptions to the average are easily found and often quoted as typical. The truth is, too many people do not want facts. They are afraid such facts will not substantiate their beliefs. People simply want to believe they can have more themselves without producing more in return. Here is a breakdown in morality and in those principles of good human behavior which have marked the advance of this country in generations past.

It is easy to mislead people in such matters as this. When folks hear on high authority that X company has sales of one hundred million dollars and pays but twenty-five millions in wages, it looks "OK" to them that a 30 per cent increase in wages means but a $7\frac{1}{2}$ per cent increase in sales price. That "small" increase, they can see, can be picked up through the magic of mass production, by reducing "unreasonable profits," or, if necessary, the $7\frac{1}{2}$ per cent can be paid and the wage earner will still be ahead.

Men making these statements know they are misleading the listener. They know the seventy-five millions not paid out in wages by X company are largely expended for materials bought from others who, in turn, pay wages. This goes clear back to the coal and iron in the ground, and lumber in the trees. The actual value of the raw materials in their primitive state in any manufactured product is but a few dollars. All the rest of the cost is today's labor and yesterday's labor. We call the product of yesterday's labor, not consumed yesterday, capital.

You say this is too simple to include in a message to thinking people. That is right, but it will be doing a great service to pass it on in a kindly way to the many many people in your home community who have not had this simple truth explained and who, incidentally, are not sitting up nights looking for it.

Today we are fighting the third world war. The atom bomb of this war is more destructive than that one which landed on Hiroshima. It is the bomb of misunderstanding. It has its own chain reaction. It starts with lack of acquaintance. Remember the old inscription "Let me not know my enemy, for if I know him, he can no longer be my enemy." From lack of acquaintance the chain goes on to doubt, mistrust, hate, conflict, and destructiveness.

Our enemy in this war is using his best and most effective weapon in this attack upon our minds. The slogan on his flag is "Keep Splitting." His general orders to his troops are to produce chaos, not food, shoes, and automobiles; to create hate, not friendship; to spread despair, not peace of mind. The engineer made great contributions in World War II. He has, likewise, a real responsibility in the fighting of World War III.

SO WHAT?

This should be enough to make reasonably clear the situation facing us today. Now let us consider the question, "Why should the engineer and his technical society be concerned?"

What would you give for the assurance of a bright and free tomorrow? As stated at the beginning, I am going to ask for something which each of us regards as more valuable than money, that is, his time. I believe that there is no way to

spend money to change distrust into understanding. . .Some may question that conclusion. Would one walk up to a good-looking stranger on the street, a man he felt he would like to know, hold out to him a hundred-dollar bill and say, "My name is Joe Smith. I want you to be my friend. I want you to have confidence in me and respect me, therefore I am giving you a hundred dollars to insure this friendship." The stranger would have every reason to feel that here was an individual mentally unbalanced. If he took the money, it would stand in the way of, rather than generate, a future friendship.

Any money spent directly in this manner or on displays of well-worded full-page ads or cleverly illustrated booklets will not win the confidence and respect of those who read it, if they mistrust the integrity or the intentions of those who signed the document. Real understanding is based on friendship; friendship based on normally developed acquaintanceship. Before we can win confidence we must win respect. Industry can win back its friends of yesterday only if men of industry devote "time" to it, or if those others who understand will explain the workings of our free economy and its great service to all the citizens of this land and the world. Here is a retail job to be done, one at a time, among those who distrust or question the service of private ownership, of the "American way."

I know of officers of local engineering sections who vigorously and honestly feel that no subject which cannot qualify as a strictly engineering matter should come before their sections. They are particularly averse to any subject which might be called political or controversial outside the narrow field of technical controversy. As engineers, we are proud to say that we deal with facts—we build, we serve, we improve. If we can put it on a slide rule, it's ours, otherwise not. I have even heard some engineers say they would not care particularly as to the form of society in which they served since all forms of society need the engineer. This is a deadly and destructive viewpoint, but I know that it exists, in a very limited degree only, among the engineers of this country.

Engineers possess in common an analytical or logical way of thinking. Dealing with facts and materials, the characteristics of which are largely known, has removed the engineer from the field of emotional thinking and reaction. It is this characteristic of the engineer which peculiarly fits him to deal with this troublesome problem now facing society. The engineer quickly sees the fallacious reasoning behind such statements as "Better a planned than a planless society" or "Human rights come ahead of property rights." Because engineers tend to associate mainly with other engineers, they and their associates label such statements false. They fail to recognize the wide appeal of these clever mis-statements, each one planned to give the listener the hope that he can have more than the other fellow without having to assume more responsibility or exert any more energy.

Let's examine the statement, Human rights come ahead of property rights. The very essence of our free economy is the right of an individual to possess those things which he has lawfully accumulated for his own. It is not possible for a pig or a river to own property; only humans can own property. Human rights and property rights are not in conflict. The real issue is, shall we have a free economy where human beings have property rights, may own a car, a home, and provide for the future, or shall we have a society where the human has no property or other rights not granted him by the distant uncaring hand of the dictator?

Another reason why the engineer must assume responsibility in this field of developing understanding is the simple fact that, through his demonstrated performance in peace and war, he has won the confidence of the general public. The promises of the engineer are fulfilled, his buildings stand, his machines operate, his airplanes fly. He is in a position of great influence. He has not yet placed himself on either side of this controversy. His habit of analyzing, his factual presentation are vitally needed now. He has learned to discuss matters without emotion. He is a good listener. He has friends in all walks of life. He lives in all parts of this great land—the cities, the towns, and the country. My sincere hope is that this message may help even one more engineer to see his responsibility. I have every confidence that what he does about it will be good.

WHAT YOU CAN DO ABOUT IT

So we come to the question, "What is our job, what can we do about it?" How can we bring about understanding and help build the dams which will confine the floods of misunderstanding and distrust?

First, I suggest that you work at home. Work in your own community where you know people. After all, the community is the only real unit of society in the world. In fact, your state, this nation, or even the world is simply the sum of all its communities. It is within the community that real understanding can be recreated, for here people see each other, and by seeing people day after day real friendships can be developed. If our communities are bound together with the cement of understanding and friendship, no wedge of distrust or hate inserted at the national level can tear us apart.

The engineer is traditionally a man who has worked for things rather than against things. In my field of agricultural engineering we have been for labor-saving efficiency in agricultural production, not against primitive agriculture. So here the engineer does not need to take up the banner against a philosophy, a group, or even an individual. Look what we have to work for. We know the demonstrated effectiveness of our system of free economy when wisely regulated by good laws. That is what we are for, and we can help interpret all its benefits as it affects every individual.

As a definite project, if there is belief in even a fraction of what I have said, members of this Society should make sure that each section program contains a discussion each year on some phase of the subject, "The Engineers' Responsibility as a Citizen." Instead of ducking political office, discuss the kind of jobs in your community where engineers can serve best. It will not be surprising to learn that every city council, park board, sanitary district, or state or national legislature today needs engineering knowledge. Encourage, not discourage, political activity. How many junior members are fully acquainted with the political organizations in their community, their duties, how those who carry out the work are elected or appointed? How many members have ever considered running for the job of precinct committeeman of their party?

Leaving the field of politics, how about the many other organizations set up to make living better within your community? Engineers have a place in all of them. The Boy Scouts, the 4-H Club, Future Farmers of America, and their relatively new counterpart, Junior Achievement. In this latter youth group, the boys and girls of our cities are learning the fundamentals of how business is organized and carried on, the real meaning of production and sales costs, profits, and dividends. Encourage every engineer in your community to identify himself with some organization in which there is a cross section of citizens of your community. You have no alibi if you work in a large city, for every man lives in some community.

You will be amazed at the number of cultured and educated people in the professions, in women's organizations, and elsewhere who sincerely hold false views concerning the operation of our industrial system. Most of their conclusions are based not on facts or logical thinking but rather on emotion and de-

sires. They welcome every opportunity to get the facts. Engineers are builders. Here is a challenge to become builders of understanding at home in your community, where your work can count for the most.

As engineers, some of us have become so involved within the intricate mechanism of industry that we have failed to keep up with some of its own terminology. How many of us can clearly and effectively answer the workman in a plant who sees in the annual statement of his company "Surplus—$9,600,000," and asks why the company cannot afford a generous wage increase? This employee likely looks upon this surplus as a lot of extra unused, unneeded dollars. Can you explain to him that the "dollar" is used as a measuring stick for buildings, machinery, land, piece parts, and materials which make up the factory? Could you tell him that this surplus largely came from profits which were reinvested in the business, and then go even further and point out clearly and kindly that wages should be based on the value of the service rendered? "It would be a shyster trick," we should say, "to sell the employee the idea that his wages should depend entirely upon the ability of the employer to pay." Then, whenever the net income of the business dropped, the employee would find his pay taking a distressing decrease, if not vanishing, as profits have a habit of doing from time to time in nearly all companies.

It is true that industry has failed miserably in interpreting its jargon to those interested. However, it will do no good to blame others, for remember we are all in the same boat and will go together down the whirlpool of totalitarianism or go out together on the broad ocean of free men.

This is not a job for the economist, or the teacher, or the accountant. It is a job for all of us, and the engineer cannot duck his responsibility. We are the main transgressors in this game, if we take just the engineers' piece out of the economic pie, shove the rest across the table, and say, "This belongs to someone else, I don't care who."

Disregard this, and the many other warnings now being given, as to the need to develop community understanding, and you are placing yourself one step closer to the day when you will become a nameless cog in the gigantic mesh of totalitarianism. Here we will be cogs in a machine with no reverse gear, no way to go back to that which we once had, no way to register our dismay at unfulfilled promises. Those were promises which were impossible to fulfill anyway. In the history of the world, the totalitarian machine never backs up, it grinds and grinds, finally stalling from the growing friction of its own multiplied inefficiencies.

Do you need another reason for action? If so, here is one. It is a lot of fun to make new acquaintances among folks who think differently from you. You will find practically every one of them sincere, wanting to be right. It is good to make new friends. It will help you in your daily work. You will be a better engineer.

Tackle this job in your own way in your own community. Bring together discussion groups representing the various areas of thinking in your community. Bring in representatives of clergy, labor, education, government, leaders of women's organizations. Talks should be given by members of your own group. I advise against importing outside speakers. Get acquainted—swap ideas!

Don't be afraid to pick "hot" subjects. I would advise, however, that the first several meetings be devoted to getting acquainted and discussing an interesting but not too hot subject. Try starting on "The Place of the Home in Education," or "Are Today's Schools Fitting People for Tomorrow's Living?" Soon, however, try "The Place of Government in a Free Economy," "What Is Capitalism?" "What is the Profit Motive?" "Can the Government Guarantee Jobs?" "What Is the Responsibility of Management, Not Alone to the Employee, But to the Customer and Investor?" Look into the annual-wage plan and see what it takes to make it operate well. Find correct definitions for such words as surplus, profit, investor, and learn that depreciation is not a term used to hide profits as some people choose to believe. Above all, learn to listen to the man who firmly believes in a different type of social organization from what do you. Listen courteously and honestly. You will find that if you will listen to him he will then listen to you. You will part as friends, each with some of the thinking of the other and, remember, right ideas have the best chance to prevail. The engineers in my community have been following this practice for a number of years. It works!

So here is your job as an engineer, as an influential member of your local program committee, as a citizen. Remember, this assignment of getting busy and re-establishing understanding within your community is one of vital importance to you. We in this country are going to sink or swim together. Select right now one thing you will do in your home community to build toward better understanding and mutual confidence and trust. You might start with your milkman, but start!

Automatic Ionosphere Recorder

A NEW instrument for automatic recording of ionospheric phenomena, which are of great practical importance in radio propagation, has been developed by the Central Radio Propagation Laboratory of the National Bureau of Standards. Now in operation at the Bureau's ionospheric research station at Sterling, Va., the protoype model C2 recorder was completed in time to participate in the recent Army Air Forces—National Geographic Society Eclipse Expedition in Brazil, where, in addition to special records during the May 20 eclipse of the sun, valuable data were obtained on general ionosphere conditions. An analysis of this information will add to the fundamental knowledge of the ionosphere.

Long-distance radio transmission would be impossible if it were not for this outer envelope of the earth, the ionosphere, which reflects radio waves back to earth. The wide fluctuation in ionosphere characteristics, that is, changes in its degree of ionization due to varying amounts of ultraviolet light from the sun, causes radio propagation to vary daily, seasonally, and over the sunspot cycle. By systematic analysis of these changes over the entire surface of the earth, the National Bureau of Standards predicts ionospheric conditions three months in advance. Such predictions permit accurate calculation of the best radio frequency to use at any given time between any two points on the earth, information which is important to the Federal Government, the Army and Navy, and the communications industry as a whole. The new recorder will aid in this prediction service as well as in basic research by providing data on ionosphere characteristics through automatic and continuous measurements of critical frequency, and the heights of the various layers. Plans are being made to install recorders in all the ionosphere stations operated by the Bureau.

The model C2 recorder was designed to utilize the so-called multifrequency technique of investigating the layers of the ionosphere beginning at 60 and extending to more than 100 miles above the earth's surface. Pulse transmissions are used similar to those employed in radar, except with varying probing frequency. The frequency is plotted against the time delay of the echoes from the ionosphere, an interval corresponding to twice the height of reflection. One sweep in frequency from the lower to the upper limits produces each ionosphere record in a time interval of as little as $7\frac{1}{2}$ sec.

HISTORY *and* EXPOSITION *of* *the* LAWS *of* THERMODYNAMICS

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HISTORICAL INTRODUCTION

ALTHOUGH the science of thermodynamics has now reached its centennial, it is only in the last half century that the basic concepts and definitions have been clarified. This clarification has brought us to the point where it is profitable to re-examine our methods of expounding the First and Second Laws in order to select and to compare those that seem presently to be valid. The macroscopic, or phenomenological, viewpoint will be considered exclusively, since, at present this leads to the most general conclusions.

Thermodynamics grew out of the caloric theory and, to a lesser degree, Newtonian mechanics. Three concepts seem to have been basic in the caloric theory: first, that caloric was a substance without mass which was contained within material systems and was conserved in all processes; second, that the amount of caloric in a system was fixed by the state of the system and was therefore a property; third, that an increase in caloric was usually accompanied by a rise in temperature for systems in equilibrium states. Caloric was thus associated with hotness and transfer of caloric with heating and cooling.

It appears that the first attempts to destroy the caloric theory were aimed at the first of these concepts, namely, the conservation of caloric. Rumford (1)[3] in 1798 and Davy (2) in 1799 attempted to show by experiments involving frictional work that the caloric of one body could be increased without decreasing the caloric in any other body, that is, a body could be heated without cooling any other body.

The words caloric and heat were used to some extent interchangeably, and little effort was made to distinguish between the caloric or heat in a body and transient quantities which were presumably the transfer of caloric or heat from one body to another.

In 1824 Carnot (3) introduced several new concepts. The first was the cycle, the process which left no net change in the condition of a system; the second was reversibility; and the third was the principle that no cyclic device could produce more work than a reversible cyclic device for a given amount of heat and for given reservoirs.

The introduction of the cycle caused Carnot to restrict his discussion of caloric to exchange of caloric between reservoir and system. This was the first instance of the consistent use in a thermodynamic argument of the quantity which is heat in the modern sense of the term. Many years were to elapse before this usage was to become established.

Carnot's principle that the reversible cyclic engine is the most efficient engine possible was in reality the Second Law of Thermodynamics. Carnot tried to prove this principle by reference to two principles which he considered to be more basic, namely, the conservation of caloric and the impossibility of a cyclic machine which would produce work and leave no other effects. This latter device is now known as a perpetual-motion machine of the first kind. The proof was, of course, invalid. Nearly twenty years later Clausius asserted that Carnot's principle was itself basic and could not be proved by reference to other basic concepts.

During the period from 1840 to 1848, Joule (4) laid the experimental foundations for the First Law by a series of investigations which were remarkable not only for the breadth of their conception but also for the unsurpassed experimental skill employed in their execution. He made measurements to show that the *amount* of work required to bring about a given change of state was independent of the kind of work (whether mechanical, electrical, magnetic, etc.), the rate of doing the work, or the method of delivering the work. Experiments were made with systems consisting of single fluids such as water, air, sperm oil, and mercury, and of several fluids reacting chemically.

Although he did not discuss cycles explicitly, he carried out different experiments on the same system such that they might easily have been combined into cycles. While he rejected the caloric theory, he did not entirely abandon the concept of heat as a property of a system, and the generalizations of his observed results were not well stated. Nevertheless, to Joule must be given the principal credit for making thermodynamics a quantitative science and for making measurements which served as a basis for the generalizations of Kelvin and Clausius.

In 1844 Mayer (5) deduced a relation between work and heat by an inconclusive comparison of constant-volume and constant-pressure processes between the same pair of isotherms in a gas, using measured data on specific heats.

In 1847 Helmholtz (6) accepted the conclusions of Joule as to the relations between work and changes of state and attempted to rationalize these conclusions by reference to a system of discrete particles through the Newtonian laws of motion. That is, he showed that when work was applied to a conservative mechanical system it would produce effects analogous to heating effects in a real system. His efforts were typical of the viewpoint in science which prevailed till near the end of the nineteenth century, a viewpoint from which natural phenomena were "understood" only after they had been reduced to Newtonian mechanics.

To state in adequate terms the contribution of each of these pioneers in thermodynamics is virtually impossible. Their concepts were confused and their definitions vague as viewed from the present state of the science. For example, no single definition seems to fit the various usages of the term *heat*, whereas other terms of frequent occurrence were often even more vague in meaning. Among these others was the term *motion* which was used on different occasions to denote momentum (as in Newton's Laws), and work (as in a "perpetual-motion machine").

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Presented at the A.S.E.E.-A.S.M.E. Summer School for Teachers of Mechanical Engineering, Northwestern University, Evanston, Ill., June 14-18, 1947.

It appears, however, that Helmholtz was the first to try to rationalize thermodynamics through Newtonian mechanics. Here began the so-called mechanical theory of heat which can be traced through Clausius and Maxwell to modern times. Although this was a vital part of the development of the kinetic theory of gases, it was a source of great confusion in the science of thermodynamics.

In 1849 Kelvin (7) pointed out the conflict between the caloric basis of Carnot's argument and the conclusions reached by Joule. He called for further experiment to resolve the dilemma.

Without benefit of further experiment Clausius (8), in 1850, reconciled Carnot's principle with the work of Joule and Mayer. He did this by proposing Carnot's principle as an independent law not requiring proof by reference to other principles, and by demonstrating that the caloric theory could then with no logical inconsistency be dropped in favor of the new principle of Joule and Mayer.

The work of Clausius at this date and subsequently included many statements which were unexceptionable from our present standpoint. On the other hand, these excellent formulations were commonly made subordinate to statements which ranged from the vague to the utterly confusing. Perhaps the greatest source of confusion was his insistence on the dynamic rationalization which was initiated by Helmholtz. We note, for example, that by writing the equation

$$dQ = dU + AdW$$

he distinguished clearly for the first time between heat and internal energy. This feat was marred, however, by his subdivision of U into two parts, neither of which could be measured, and by using the term heat for both Q and U.

He was clear on the proportionality between heat and work in a cycle. It was typical, however, of his exposition, that this simple and important fact was dropped into his argument rather casually.

Kelvin emphasized the importance of this concept in 1851, by expressly crediting Carnot with the introduction of the cycle into thermodynamic reasoning. He credited Carnot and Clausius with the Second Law and proceeded to devise a temperature scale in terms of it. His concept of heat, however, was still not clear. As late as 1878, he referred to heat as "a mode of motion."

In 1865 Clausius (9) stated that the quantity U must be thought of as the sum of "free heat" and "consumed heat corresponding to internal work." He also attempted to distinguish between stored heat and stored work. It was such devious excursions that led Maxwell (10), in 1868, to comment as follows: "But though Clausius thus gets rid of all the heat which, after entering a body, is expended in doing work, either exterior or interior, he allows a certain quantity to remain in the body as heat, and this remnant of what should have been utterly destroyed lives on in a sort of smouldering existence, breaking out now and then with just enough vigor to mar the scientific coherence of what might have been a well-compacted system of thermodynamics." One's impulse to cheer this clarion call to clarity is stifled upon reading a later pronouncement by Maxwell to the effect that "Heat may therefore pass out of one body into another just as water may be poured from one vessel to another, and it may be retained in a body for any time."

Although Gibbs (11) had probably the broadest understanding of thermodynamics of any man before his time or since, he seems not to have stated the definitions of either heat or internal energy. In a footnote to his second paper of 1873, he defined work done by a system quite clearly. He says that we get this magnitude by answering the question: "How great a weight does the [process] enable us to raise a given distance, no other permanent change being produced in external bodies."

In 1897 Planck (12) demonstrated the close connection between the Second Law and the concept of reversibility. He stated the Second Law as the impossibility of a cyclic device which produces positive work and exchanges heat with a single reservoir. This statement seems to have been one of several statements made by Kelvin. The cyclic device so described is now called a perpetual-motion machine of the second kind. Planck showed clearly that our observations regarding the irreversibility of many processes in nature are equivalent to his statement of the Second Law.

Kelvin's statements of the Second Law, and in particular the one selected by Planck, were quite adequate. No equally adequate statement of the First Law had appeared up to the turn of the century. Two hurdles had to be cleared before an adequate statement was possible. The first was a legacy of the caloric theory in the form of the concept that heat was somehow a property and was therefore more intimately associated with internal energy than was work. The second was the mechanical theory of heat which implied that the fact that internal energy was a property was a consequence of the Newtonian laws of motion.

These difficulties were completely resolved by Poincaré (13) in 1908. In Poincaré is found for the first time a structure of reasoning based on consistent definitions of measurable quantities and culminating in a statement of the First Law. He gives a complete definition of temperature, a statement of the axiom sometimes called the Zeroth Law, and a definition of heat.

The First Law, according to Poincaré, is that heat and work are proportional to each other in cyclic processes. He then defines the increment in internal energy as the difference between heat and work and proves by reference to the First Law that the internal energy is a property.

A year later (1909) Caratheodory (14) presented another structure of reasoning different from that of Poincaré but equally complete and rigorous. Here the basic concepts are work and the so-called *adiabatic wall*. The First Law is stated in the following form: An extensive property exists the increment in which is equal to the work received by the system while it is surrounded by an adiabatic wall.

Caratheodory's statement of the Second Law is perhaps a more radical departure from previous history than his statement of the First Law. It may be given in the following form: In all neighborhoods of any prescribed initial state there are states which cannot be reached by a [quasi-static] adiabatic process.

The word *quasi-static* was not included in Caratheodory's statement, but is implied by his subsequent development of the consequences of this statement. He defined a *quasi-static* process as one for which all states passed through are equilibrium states. In other words, it is a process which is reversible as regards events within and at the boundary of the system.

Caratheodory's purpose was to state each law in such a way that all subsequent reasoning could be entirely in mathematical form. By contrast Poincaré's method involves physical reasoning in terms of verbal logic. For example, Poincaré must define reversibility in words by reference to the Second Law, whereas Caratheodory arrives at the concept of reversibility through mathematical symbolism.

FOUR STATEMENTS OF THE FIRST LAW

The methods of Poincaré and of Caratheodory appear to be the only logically complete structures for exposition of the First Law that have been published. Examination of these structures suggests, however, two additional ones. These four structures are given in some detail below. It will be noted that Method I is that of Poincaré and Method II that of Caratheodory.

The following definitions are common to all four methods:

System. A thermodynamic system is any prescribed collection of matter. The boundaries of a system are, therefore, impermeable to matter—although they may be extensible and contractile. In considerations of radiation a system may be merely space enclosed by boundaries impermeable to matter.

Property. A property of a thermodynamic system is an observable characteristic in the macroscopic sense.

State. The state of a system is the condition of the system. States are identified by means of properties. Identical states have identical properties. The change in a property is fixed by the end states of a change of state.

Process. A process is that which brings about a change of state. A process may be sufficiently described, as regards the system in question, in terms of the series of states passed through. Departures from uniformity of state must be indicated even if they are transition conditions between uniform states.

Cycle. A cycle is a process whose end states are identical.

METHOD 1

Initially Defined Quantities:

Work. Work is an effect of one system on another which is identified and measured according to the following rules:

Work flows from system A and to its environment during a given process in A if A could pass through the same process while the sole effect external to A was the rise of a weight.

The number which represents the magnitude of the work is found by counting the number of standard weights which can be raised by A from one selected level to another.

The amount of work flowing from system A is identical with the amount of work flowing to its environment—in this case the system B which is the part of the environment affected by A. The definition of work flowing from a system, as just given, cannot be reversed to get the definition of work flowing to a system.

Work flowing from a system is represented by positive numbers—work flowing to a system by negative numbers. Thus, letting W_A and W_B denote work of systems A and B, respectively, we get

$$W_A = -W_B \quad \ldots\ldots [1]$$

Equality of Temperature. Any pair of systems, in the absence of any extraordinary barrier between them, will in general affect each other even in the absence of work. The systems may be said to be in communication. If they are in communication only with each other then the changes in the two systems, will, in time, gradually decrease in rate. The condition which the pair approaches as a limit is called equality of temperature.

Associated with this definition is an axiom, sometimes called the Zeroth Law of Thermodynamics, to the effect that two systems which are each equal in temperature to a third system are equal in temperature to each other.

It is a matter of experience that certain levels of temperature are reproducible and readily maintained—such as that of a mixture of ice and liquid water under a pressure of one standard atmosphere.

A temperature scale may now be defined in terms of the magnitude of a selected property of a prescribed system under prescribed restraints as to pressure, volume, nature of the container, etc. The number representing the level of temperature will be some prescribed function of the magnitude of the selected property, and constants in the functional relationship will be established by arbitrarily assigning values to certain reproducible levels.

Heat. The definition of equality of temperature implies the existence of conditions of inequality of temperature for which the two systems in communication have an effect on each other. This effect is called heat.

Heat is identified and measured according to the following rules:

Heat is the effect of one system on another by virtue of inequality of temperature.

The number which represents the magnitude of the heat for a process of system A is found by counting the number of standard systems in communication with A which will go from one prescribed level of temperature to another as a result of the heat effect in question. For the purpose of this test system A must exchange heat during the process only with the standard systems which are subjected to prescribed restraints as to pressure, volume, nature of container, etc.

Heat is said to flow to a system which is in communication with a standard system when the standard system changes in a prescribed direction between the standard levels of temperature. In practice we say that heat flows to system A when the standard system with which it communicates passes from a level of temperature corresponding to boiling water to that of freezing water, both under a pressure of one atmosphere. In more subjective terms, heat flows to system A when the standard system gets colder.

The amount of heat flowing to a system is equal to the amount of heat flowing from its environment.

Heat flowing to a system is represented by positive numbers—heat flowing from a system by negative numbers. Thus, letting Q_A and Q_B denote the heat quantities for two systems, A and B, respectively, which are in communication only with each other, we get

$$Q_A = -Q_B \quad \ldots\ldots [2]$$

Two kinds of isolation have just been referred to: first, the kind required for two systems as they approach equality of temperature, and, second, the kind required for measurement of heat. In the first instance it is only necessary to provide a wall of inert material of sufficient thickness. Inertness here implies that no active tendency to change exists within the wall material itself. Since isolation from other elements of the environment is complete only if the wall is of infinite thickness, this concept is an extrapolated one.

The second kind of isolation which is involved in the measurement of heat cannot be simply a wall of infinite thickness because such a wall would in itself affect the measurement by affecting the system, the standard bodies, or both. However, a wall the inner surface of which is controlled so as to have the same temperature as the part of the system with which it communicates would be adequate.

The First Law:

The First Law is now stated entirely in terms of heat and work, as follows:

In a cyclic process the net heat is proportional to the net work. In terms of symbols, we have

$$\oint dW = J \oint dQ \quad \ldots\ldots [3]$$

where the magnitude of J depends only on the units of work and heat. Since by selecting an appropriate pair of units J may be made unity, the equation may be written for any such pair in the form

$$\oint dW = \oint dQ \quad \ldots\ldots [4]$$

The immediate corollary of this statement is that a property E exists, the change in which is given by the definition

$$dE \equiv dQ - dW \quad \ldots\ldots [5]$$

The proof of this corollary is the combination of [4] and [5] to give

$$\oint dE = \oint dQ - \oint dW = 0 \quad [6]$$

METHOD II

Initially Defined Quantities. (None to be drawn from previous method except as indicated.)

Work. Work is defined as in Method I.

Adiabatic Wall. An adiabatic wall is an extraordinary barrier between two systems which in the absence of work prevents or reduces to an order of slowness greater than that of any process under consideration the changes in systems resulting from interaction between them; moreover, an adiabatic wall must never in itself affect the state of a system.

To illustrate the requirements for an adiabatic wall let us take for example the expansion of a gas within adiabatic walls as it does work on a moving boundary. The walls must prevent interaction of the system with neighboring systems, except through work, and must not themselves be affected by the system. To fulfill these requirements we might devise a barrier consisting of a completely evacuated space the inner (system-side) wall of which is infinitesimal in thickness and perfectly reflecting. Since this wall must support the pressure of the system, it is evident from this consideration alone that we have not devised a practicable adiabatic wall.

The adiabatic wall may be thought of as an extrapolated concept. By employing walls, such as the one described above, with different degrees of evacuation, different wall thicknesses, and different degrees of reflectivity, the performance of the system in the presence of a wall with perfect vacuum, infinitesimal wall thickness, and perfect reflectivity may be deduced.

The First Law:

The First Law is now stated entirely in terms of work and the adiabatic wall, as follows:

The work done by a system which is surrounded by an adiabatic wall is fixed by the end states of the system and is independent of the nature of the process.

The immediate corollary of this statement is that a property E may be defined, the decrease in which is given by the work done by the system in the presence of an adiabatic wall. Thus

$$dE = -dW_a \quad [7]$$

where subscript a indicates an adiabatic process or the presence of an adiabatic wall.

It is a matter of experience that, with few exceptions, adiabatic changes of state can be executed in only one direction, a generalization which in terms of Second Law concepts is known as the principle of the increase of entropy. This restriction on the direction of the process does not reduce the significance of the First Law as stated above. The evaluation of changes in E only for a certain kind of process which generally may occur only in a single direction is equivalent, in the Second Law development, to the evaluation of changes in entropy only for a certain class of processes, namely, reversible processes.

Heat. Heat is now defined in terms of work and the property E, thus

$$dQ \equiv dW + dE \quad [8]$$

or the equivalent statement

$$dQ \equiv dW - dW_a$$

From this definition it may be shown that the amount of heat flowing to a system is equal to the amount of heat flowing from its environment, that is, that

$$Q_A = -Q_B$$

The proof is as follows:

Let systems A and B be in communication while they are surrounded by an adiabatic wall through which no work is allowed to pass. Then we may write

$$Q_A = W_A + \Delta E_A \quad [9]$$

and

$$Q_B = W_B + \Delta E_B \quad [10]$$

But, by the definition of work

$$W_A = -W_B \quad [11]$$

so that by adding [9] and [10] and employing [11] we get

$$Q_A + Q_B = \Delta E_A + \Delta E_B = \Delta E_{AB} \quad [12]$$

where ΔE_{AB} denotes the increase in E for the system comprising both A and B.

By the definition of E we have

$$\Delta E_{AB} = -(W_{AB})_a$$

and this is zero by the conditions imposed. Therefore

$$\Delta E_{AB} = 0$$

and, by [12]

$$Q_A + Q_B = 0$$

or

$$Q_A = -Q_B$$

Q.E.D.

The heat so defined has one characteristic in common with the heat of Method I, namely, that it is associated with an interaction between a system and its environment which can occur in the absence of adiabatic walls and in the absence of work. Also, from consideration of processes in which the work is zero, it may be shown that the *equality of temperature of Method I* is, in the language of Method II, associated with the condition for which the heat is zero in the absence of an adiabatic wall. Therefore, equality of temperature for Method II may now be defined as that condition for which, in the absence of an adiabatic wall, the heat is zero.

It remains to be shown that the heat of Method I (Q_I) is identical with the heat of Method II (Q_{II}), and that the change in E of Method I (dE_I) is identical with the change in E of Method II (dE_{II}).

Consider a cycle of operations. Then, from the First Law of Method I

$$\oint dQ_I = \oint dW_I$$

Also, since E_{II} is a property

$$\oint dQ_{II} = \oint dW_{II}$$

But dW_I and dW_{II} are equal, since they are defined identically, and therefore

$$\oint dW_I = \oint dW_{II}$$

from which it follows that

$$\oint dQ_I = \oint dQ_{II}$$

and, since both the cycle and system are arbitrary

$$dQ_I = dQ_{II}$$

Now, by definition of dE_I

$$dE_I \equiv dQ_I - dW_I$$

and, by definition of dQ_{II}

$$dE_{II} \equiv dQ_{II} - dW_{II}$$

But it has just been shown that

$$dQ_I = dQ_{II}$$

and, by virtue of their definitions

$$dW_I = dW_{II}$$

so that

$$dE_I = dE_{II}$$

Q.E.D.

METHOD III

An alternative to Method II may be devised in which the concept of equality of temperature is substituted for that of the adiabatic wall in the list of initially defined quantities.

Initially Defined Quantities. (None to be drawn from previous methods except as indicated):

Work. Work is defined as in Method I.

Equality of Temperature. Equality of temperature is defined as in Method I.

The First Law:

The work done by a system which is entirely surrounded by bodies which are at each point of communication equal in temperature to the system is fixed by the end states of the system and is independent of the nature of the process.

As in Method II, a property E may now be defined by means of the equation

$$dE = -dW_e$$

where subscript e indicates a process in which the system is exposed only to an environment of equal temperature.

As in Method II, processes for measuring E can be executed in general in only one direction.

The proof of equivalence between Q_{III} and Q_I and between dE_{III} and dE_I is entirely parallel to the corresponding proof given in the comparison between Methods II and I.

The heat received by a system which is in communication with other systems only through a zero-work wall is fixed by the end states of the system and is independent of the nature of the process.

The immediate corollary of this statement is that a property E may be defined, the increase in which is given by the heat received by the system in the presence of a zero-work wall. Thus

$$dE = dQ_z$$

where subscript z indicates the presence of a zero-work wall.

It is a matter of experience that, barring complicated apparatus, changes of state can usually be executed in only one direction in the presence of a zero-work wall.

Work. Work done by a system is now defined in terms of heat and the property E, thus

$$dW \equiv dQ - dE$$

or the equivalent statement

$$dW \equiv dQ - dQ_z$$

From this definition it may be shown that the amount of work flowing from a system is equal to the amount flowing to its environment—that is, that

$$W_A = -W_B$$

The proof of this statement is entirely analogous to the corresponding proof for heat in Method II. The systems A and B are first surrounded by a zero-work wall through which no heat is allowed to pass. The remainder of the proof is obvious.

The work so defined has one characteristic in common with the work of Method I, namely, that it is associated with an interaction between a system and its environment in the absence of a zero-work wall.

It remains to be shown that the work of Method IV is identical with the work of Method I and that the change in E of Method IV is identical with the change in E of Method I. These facts may be demonstrated by a proof which parallels exactly the corresponding proof of equivalence between the defined and derived quantities of Methods I and II.

SUMMARY OF METHODS I, II, III, IV

Method	I	II	III	IV
Concepts defined initially	Work Temperature Heat	Work Adiabatic wall	Work Temperature	Temperature Heat Zero-work wall
First Law	$\int dW = J \int dQ$	$\int_1^2 dW_e = f(1,2)$	$\int_1^2 dW_e = f(1,2)$	$\int_1^2 dQ_z = f(1,2)$
Definition of increment of property E	$JdQ - dW$	$-dW_e$	$-dW_e$	dQ_z
Derived definition of heat	.....	$dW - dW_e$	$dW - dW_e$	.....
Derived definition of work	.....	.....	.....	$dQ - dQ_z$
Derived concepts	Adiabatic wall Zero-work wall	Heat Temperature Zero-work wall	Heat Adiabatic wall Zero-work wall	Work Adiabatic wall

METHOD IV

Initially Defined Quantities. (None to be drawn from previous methods except as indicated.)

Equality of Temperature. Equality of temperature is defined as in Method I.

Heat. Heat is defined as in Method I.

Zero-Work Wall. A zero-work wall is a wall which is motionless (except in the absence of force at the wall) and through which pass no moving force fields and no electrical currents.

The First Law:

The First Law is now stated entirely in terms of heat and the zero-work wall, as follows:

COMPARISON OF METHODS

Since these four methods of presenting the First Law lead to identical concepts and quantities it appears that choice among them must be largely a matter of taste. Nevertheless, some comparisons may be made which will point up certain rational or historical advantages which one method may have over the other.

Method I has a certain historical justification in that its primary quantities, work and heat, were familiar to scientists before the advent of thermodynamics. Work was the basis of the principle of virtual displacements which antedates the laws of motion. Heat is as old as calorimetry which in some forms antedates the caloric theory.

It appears that Method II requires the smallest number of initially defined quantities. From the standpoint of the teacher it is doubtful whether this in itself is a significant advantage. To offset it somewhat we have the difficult concept of the adiabatic wall. The techniques of identifying a wall which reduces to an order of slowness greater than that of any process under consideration the changes in systems resulting from interaction between them and which at the same time never in itself affects the state of the system are not easy to anticipate.

It might be argued that Method I requires a kind of adiabatic wall in its definition of equality of temperature and is therefore no better off in this regard. The isolation device of Method I, however, is simpler in concept and in reality. It is not required that it should not affect the system while the system experiences a process, but only that it should protect the system in an equilibrium state from the effects of external things. Ordinary insulation thus approximates the isolator of Method I—the degree of approximation depending, for a given insulator, only on the thickness.

The method of isolation required in Method III is essentially that of precision laboratory practice. In this regard Method III appears to be a more natural approach than Method II.

Comparison of Methods II and III indicates equivalence between a process which is adiabatic and one which involves equality of temperature between system and environment. This is apparently in conflict with the concept of reversible heat exchange between a system and its environment which arises in discussions of the Second Law. The conflict is resolved by a consideration of time rates. In reversible heat exchange the time rate of heat flow must be of the same order as the time rate of the process, whereas in an adiabatic process the rate of heat flow must be of a slower order than that of the process.

The concepts of equality of temperature and the adiabatic wall are each defined in terms of freedom from effect. The freedom from effect must be for the period of the processes in question. A certain wall may be adiabatic for processes which occur at finite rate but not for processes of infinite slowness. A certain degree of equality of temperature may insure freedom from effect in processes which occur at finite rate but not in processes of infinite slowness. For heat transfer to be reversible in the Second Law sense, the degree of equality of temperature must be so great that finite effects can occur only in infinite time.

Method IV seems to have the advantage that a zero-work wall is easier to devise than an adiabatic wall. Moreover, work as a quantitative concept was adequately understood so much earlier than heat that ability to identify work, or zero work, seems to be an entirely reasonable presumption upon entering the science of thermodynamics—perhaps more reasonable than the presumption of ability to determine zero heat.

A GENERALIZED STATEMENT OF THE SECOND LAW

Some generalization of the nonmathematical approach to the Second Law seems possible at this point. The development given below applies to the classical approach which stems from Carnot through Kelvin and Planck. It is closely allied to the method of Caratheodory although its object is not to minimize the physical reasoning in favor of the mathematical.

Let us state the Second Law as follows:

A perpetual-motion machine of the second kind is impossible. Here the term perpetual-motion machine of the second kind, hereafter denoted by PMM2, refers to a system which operates in a cycle and delivers work to its environment while exchanging heat with a single reservoir of uniform temperature.

Next, let us define an irreversible process as follows:

An irreversible process is one the effects of which, inside and outside the system, cannot be undone without permitting a violation of the Second Law. A process is proved to be irreversible by the following steps: We note that the process in question is either reversible or irreversible, the term reversible signifying not irreversible. We then assume the process to be reversible, that is, that all the effects of the process can be undone, and then show that this leads to a violation of the Second Law.

For example, consider the process which consists of the slow descent of a block on an inclined plane with friction between the block and the plane. We may consider the block to be initially and finally at rest, and the block and plane to be insulated from the environment.

To prove this process to be irreversible we first note the effects, internal and external. Including within the system both block and plane we have for external effects, none—for internal effects, the decrease in the height of the position of the block and the increase in temperature of block and plane.

Next we assume that a process can be executed, the external effects of which are none and the internal effects of which are an increase in the height of the position of the block and a decrease in temperature of block and plane.

This assumed process may now be coupled with a real process which completes a cycle, delivers work to the environment and draws heat from a single reservoir. This real process is the lowering of the block on a "lift" which is counterbalanced by an external weight and the heating of block and plane by means of a warm reservoir. Thus the cyclic process of the system has raised an external weight and drawn heat from a single reservoir. This is a PMM2 and is therefore impossible. It follows that the assumed process is impossible and the original process is therefore irreversible.

Let us call the Second Law, in the form "a PMM2 is impossible," proposition X. And let us call the statement *sliding of a block down a frictional plane is irreversible* proposition Y.

It has just been proved that *if X is true, then Y must be true.*

Next we shall show that *if Y is true, then X must be true.*

These proofs, taken together, will constitute a proof of complete equivalence between propositions X and Y. For, it follows from them that if X is false, then Y must be false, and if Y is false, then X must be false.

Let us call the irreversible process in which the block slides down the rough plane the process I. Now process I can be combined with a process J to form a cyclic process in which heat is exchanged with a single reservoir. The process J may be merely a lifting of the block to its original position and a cooling of block and plane to their original temperatures by means of a single cold reservoir. The combined process IJ, being a cycle, has no internal effects and its external effects are two, namely, the fall of a weight and the heating of a single reservoir.

Now if Y is true, then X must be either true or false. Let us assume first that X is false, that is, that a PMM2 is possible. A PMM2 may be caused to raise the weight which was lowered in cycle IJ and to cool the reservoir which was heated in that cycle. Thus, the effects of cycle IJ, and therefore of process I have been completely undone. But this is contrary to the proposition that Y is true. Therefore we have reduced to an absurdity the proposition that if Y is true, X is false. The only remaining alternative is that if Y is true then X must be true.

It follows that the proposition Y, namely, that the frictional descent of the block cannot be undone, is logically as complete a statement of the Second Law as the proposition X, namely, that a PMM2 is impossible.

The proposition Y was stated in terms of a particular irreversible process selected at random from among all reversible processes. It appears probable that the proposition Y stated in terms of any other irreversible process, such as the equalization of temperature of two bodies which are isolated from

everything but each other, the flow of electricity through a resistance, unrestrained expansion of a gas, or unrestrained combustion of a fuel, would be an equally valid statement of the Second Law. That this generalization is true may be proved as follows:

In the previous proof a cycle was devised, consisting of the process I and a real process J, for which the work was less than zero and heat was exchanged with a single reservoir. Once it is shown that such a cycle can be devised for any irreversible process whatever, then it follows that the proof herein given will hold when I is used to denote any irreversible process.

To show this, we limit consideration to irreversible processes which may be elements of cycles. That is, we exclude processes which alter the system so that it can never be restored to its original state. This involves no loss of generality, since the First and Second Laws of Thermodynamics are probably meaningless for processes in which the system is destroyed, that is, for processes which do not allow restoration of the initial state.

This limitation implies the existence of a cycle IJ. Presumably, such a cycle involves exchange of heat with one or more reservoirs and exchange of work with the environment.

A substitution of frictional dissipation of work can always be made for heat transfer to a system. Heat transfer from the system can be to a single reservoir at low enough temperature. Therefore the cycle IJ requires only a single heat reservoir and the net heat flow will be away from the system. The work of the cycle, by the First Law, must therefore be less than zero.

It follows that proposition Y stated in terms of any single irreversible process I is entirely equivalent to proposition X and is therefore a complete statement of the Second Law.

CONCLUSION

Progress in the exposition of thermodynamics has been in the direction of clarity of definition, rigor in logical developments based on principles, and more accurate interpretation of the fundamental experimental data underlying the science. The sense of mystery often associated with the science vanishes with elimination of false, inconsistent, and superfluous concepts which have long beclouded its exposition.

The survey given here shows that several patterns of exposition and of understanding are available. Needless to say, only those which are unambiguous and adequate to the development of the science are acceptable.

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Heat-Pump System Using Water Storage

(Continued from page 903)

It is difficult to predict just what effect the storage tank will have on the average coefficient of performance until several more performance tests are made. It is estimated that a coefficient of performance of 3.63 (including all auxiliary equipment) can be obtained when the water in the storage tank is heated to 120 F on a 40 F outdoor day.

The 3.27 kw used by the outdoor fan materially reduces the coefficient of performance, as indicated by curve *B* in Fig. 7. The coefficient of performance rises quite sharply as the outdoor temperature rises, mainly because of the increased compressor efficiency at the higher suction pressures.

CONCLUSIONS

1 Because of the reduction in coefficient of performance, due to the outdoor fan, it appears a higher average performance could be obtained if provision were made to reduce the fan capacity at the higher outdoor temperature and thereby reduce the electric consumption of the fan motor.

2 It appears that the efficiency of the compressor drops appreciably at the lower refrigerant temperature, accounting in part for the low coefficient of performance at low outdoor temperatures. Using a system employing a more suitable refrigerant or a different design of compressor valves would probably improve this condition.

3 The type of refrigerant valves first installed was found to be unsatisfactory owing to the high pressure drop caused in the refrigerant circuit. Valves selected for this type service must be free-acting with a negligible pressure drop to refrigerant flow.

4 The average coefficient of 3.5, indicated in Fig. 6, is believed to be conservative. By a better setting of the temperature controllers, more effective use of the storage tank at higher outdoor temperature, and a reduction in electric power consumption to the outdoor fan motor, it is felt that the coefficient of performance can be materially increased.

5 It is apparent that the load factor on a heat-pump system, using storage, will be improved materially because of the possibility of using equipment of smaller capacity operating for longer periods to satisfy a given load. The extent of this improvement on this system cannot be definitely determined until additional tests are performed.

6 It is not the intent of the authors to state that the heat pump, using water storage and air as the heat source, will result in practical applications in all cases. Experience gained elsewhere indicates that this type of system has many advantages over an air system without a storage tank, both in satisfaction of operation and higher efficiencies. The main disadvantage is probably the space requirement of the storage tank.

NATIONAL PLANNING

An American Approach by Private Citizens

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Conscious planning began comparatively late in the United States, where the frontier, states' rights, and more recently economic-group conflict, have made the formulation of the long-term national policies difficult. Today the question is who shall plan and how? One choice is state control and direction—"planned economy." The other choice is voluntary planning, which has its roots in the policies and management of companies, unions, municipalities, and industries. The National Planning Association (N.P.A.) was formed in 1934, as a private, nonprofit, and nonpartisan organization. It plans to avoid a planned economy. National policy cannot wisely be developed by any single group alone, because, to be effective, it must be accepted by all. Responsibility must be shared. The National Planning Association, therefore, organized three standing committees on national policy, one each for agriculture, business, and labor. These groups, aggregating over 200 citizens, always seek the widest area of agreement and a constructive solution of the problems confronting them. Looking to the future, N.P.A. may well become a balance wheel in our democracy, in which leaders of agriculture and labor, as well as management of business, will have an opportunity to make their sound views recognized on the national level.

PLANNING in itself is not new. It has been necessary in daily life, in the management of business, and for the survival of armed forces for thousands of years.

The more single-minded is the purpose of any individual or group, the less difficult it is to apply planning techniques. Therefore planning techniques have been more widely used in management of city and local governments in the United States than in the more complex Federal Government. Nevertheless, private planning and action by groups of citizens or individuals with some special interest have had very real influence on decisions as to national policy.

Group discussions designed to influence public opinion, and through that the legislatures, as well as organizations for the purpose of influencing Congress, long have been in existence in the United States. Such lobbying, when conscientiously done, can serve a useful purpose, but its danger lies in the fact that but few attempts are made to present Congress and the public with more than one side of a question. In recent years it had become increasingly difficult for Congress to make compromises between the opposing views of lobbying organizations, and frequently unintelligent compromises proved worse than no action at all.

OBJECTIVES OF NATIONAL PLANNING ASSOCIATION

The more complicated this nation's social structure became, the greater, therefore, the need for impartial intelligent planning.

"Planning" should not be confused with "planned economy," a phrase often associated with the concept of a totalitarian state. The National Planning Association (N.P.A.), which was organized in 1934, plans for democracy and it plans to avoid a planned economy.

The founders of N.P.A. realized that if their country were to work effectively as a true democracy, it would be vital to formulate well-conceived, long-range national policies which, when co-ordinated, would constitute a real national program. The formulation of such policies by the Federal Government is difficult—even were it desirable—for several reasons. One is the size and structure of our Government, under which each of the forty-eight states retains certain sovereign rights which were not specifically delegated to the Federal Government. Another is that under the two-party system, with a possibility of frequently changing attitudes on national issues, there is no assurance that long-range policies will be carried through. Still another is that, in a free-enterprise economy, national policy is not government policy alone, but it is a combination of private and public policies.

Leaders of the National Planning Association take the stand that the basis of the United States economy should be private enterprise, with management of private business, industry, and agriculture operating as the people's principal means for providing jobs and producing goods and services; with Government performing its constitutional function of establishing the rules of the game, acting as impartial referee, and effecting fiscal policies through taxation and expenditure programs, such as public works, that will mesh with private undertakings. It is recognized that in the case of a few basic materials such as coal or wheat, the necessity for some degree of centralized governmental control over production cannot be ruled out. However, for the multitude of products, commodities, and services, which go to make up a high standard of living, the problem of governmental planners is to establish an environment favorable to private initiative.

Under this conception of the role of government planning, however, it must be stressed that the private-enterprise system must adjust itself to a changing world. If private enterprise is to go forward, there must be a new sense of responsibility for the welfare of all the people. There must be unity of purpose among all groups, with a realization that their group interests are identical. There must be the fullest co-operation, based upon mutual trust, on the part of agriculture, business, labor, Government, and the social and educational groups. This trust cannot merely be assumed; it must be honestly earned through practice in the first place, and thereafter preserved by continuous good faith, performance, and collaboration.

N.P.A. COMMITTEES ON NATIONAL POLICY

With this in mind, three standing committees on national policy were formed by the National Planning Association: One each for agriculture, business, and labor. Because domestic issues are so tightly interwoven with international problems,

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Presented at the Eighth International Management Congress, Stockholm, Sweden, July 3 to 8, 1947.

a Committee on International Policy was also formed, and there were added informal groups of the professions and Government.

When these committees meet jointly, they constitute what one might call a congress—approximately 200 persons who approach the nation's problems with the philosophy that the individual must integrate his personal interests with those of the group, and the group in turn must integrate its interests with those of the nation.

In working out practical recommendations, the N.P.A. has certain fundamental aims as follows:

1 To find some basic yardstick which applies to all the problems of our nation. Long before the Atlantic Charter, N.P.A. insisted that its plans should bear the stamp of the fundamental human values upon which the American Christian civilization rests.

2 Being aware that differences so frequently arise because of lack of knowledge of all the facts, it is the policy of N.P.A. to test all facts carefully so that these may be instrumental in shaping the recommendations which, in turn, should be tested from the standpoint of their efficiency in producing results.

3 Since no solution should be arbitrary, efforts are made to compare all different points of view and to discuss how sincere disagreements can be compromised wisely. Attempts are made to find the widest possible area of agreement and on that basis a constructive solution of the problem is sought.

4 When that is accomplished, it is time to make a plea for energetic action. Reports presenting areas of agreement are published, and suitable ways are found for presenting them to the public so that they may study the findings and then form their own opinion. Such objective analysis is the forerunner of public action on national problems.

The aim is to lay down a general pattern for the economy as a whole and to bridge the gaps in the social structure, bearing in mind that a successful democracy cannot stand still but is subject to constant social evolution.

URGENT TASKS FACING N.P.A.

Now, it may be asked: What are the most urgent tasks before such an organization as N.P.A.?

Modern national problems require more information than any individual can supply. The task of such an organization as N.P.A. may be compared to that of an imaginary statesman of wide knowledge who seeks to combine the self-interests of free individuals with the national interest.

It is not necessarily the task of such a body to give all its time and effort to the end that the majority of the people get entirely what they think they want—for sometimes the majority may wish for something that in the long run may prove short-sighted, as, for instance, the isolation policy after the first world war. But granted that the wishes of the majority of the people are within the safe reach of a democracy, it would be the aim of the organization to show the way to attain the desires of the people and to weigh well the time element for the achievement of such desires.

What the American people want and should be able to achieve is, primarily, peace at home and abroad. Realization of this aim depends not only upon co-operative participation in the United Nations, but upon the establishment of a domestic economy that will mesh with a world economy, thus providing a stable basis for long-term peace. A violent postwar depression in America would probably prove an insurmountable obstacle to the achievement of world peace. Next, the American people desire the abolition of unemployment—or the provision for what they term "full employment opportunity."

On the subject of international and domestic peace, N.P.A. has issued a number of joint statements by the agriculture, business, and labor committees and has published timely pamphlets on such subjects as the reconversion of American industry, taxes, and fiscal policy, American opportunities in world trade, the Bretton-Woods proposal, the food and agriculture organization, a national food and nutrition program, a stable construction industry, economic recovery in Europe, and on international relief problems.

The association has pointed out that a stable economy in the United States is not only desirable from a domestic point of view but a prerequisite for a stable and peaceful world, and is essential to effective American participation in international organizations.

NEED OF MODERNIZING GOVERNMENT ORGANIZATION

In a dynamic democracy, it is vital that the legislative body at all times be able to function with efficiency. One of the more important accomplishments of N.P.A. is therefore a joint statement[2] by the standing committees which proposes constructive measures whereby the nineteenth century organization of Congress can be modernized to cope with twentieth century problems. Any joint statement by N.P.A. is always scrutinized carefully by representatives of agriculture, business, labor, and the professions. This guarantees that such recommendation does not represent sectional interests but is deemed to be in the interests of the nation as a whole. A year after publication of the joint report, Congress passed the LaFollette-Monroney Reorganization Act, which has greatly improved the machinery of Congress, but N.P.A. is continuing its efforts to stimulate the further steps necessary for congressional self-improvement.

A modernized Congress, which is able to act with sufficient alertness to create a domestic atmosphere under which stable conditions can exist and contribute to world peace, is necessary to attain the second great objective of the American people—full employment opportunity.

It seems fair to say that the elimination of unemployment has become a national objective and is necessary for the maintenance of peace.

Inasmuch as other systems of government have been able to do away with unemployment, the American democratic free-enterprise system may stand or fall on the question of whether it can solve this problem.

Full employment to the N.P.A. means that if a man desires to and can work, there should be a useful job for him somewhere in the country. It does not mean that society owes him a living, but it does mean that society owes him a chance to make a living.

The National Planning Association believes that, with teamwork between the major economic groups and Government, great progress can be made in the solution of the unemployment problem. After profound study, this conviction led to publication of its findings.[3] The conclusions reached seem to bear out the premise that the large unemployment of the 1930's had its roots in the circumstance that, while our economy had changed from that of a debtor nation to that of a creditor nation during the first world war, the habits of the people, particularly their savings habits, had not been readjusted to the new conditions.

BALANCING THE NATION'S BUDGET

When searching for ways to assure employment for all Americans who will need and want useful, profitable jobs, N.P.A. quickly recognized that prewar relationships between

[2] "Strengthening the Congress," N.P.A. pamphlet No. 39.

[3] "National Budgets for Full Employment," N.P.A. "planning" pamphlets nos. 43–44.

production, consumption, and savings would have to be changed. The nation's budget—the total of everybody's incomes and expenditures—could not be balanced unless the increase in expenditures somehow kept pace with the increase in productive capacity and efficiency. If they did not, there would be a deficiency in expenditures, or what N.P.A. calls a "gap" of approximately $9,000,000,000 which would be saved—consequently not spent, and therefore again creating unemployment and consequent depression.

Savings have always been useful and will be useful in the future. In that respect Americans should not be afraid of living up to the traditions of the past. But, in the old days, savings served two purposes: namely, (1) they were used partly to develop the enormous resources of the country, and (2) partly to produce goods and services to ship abroad in payment of the then relatively large debt, for the United States at that time was a debtor nation.

However, when America, during the first world war, turned almost overnight from a debtor nation to a creditor nation, a new situation arose. The economy had to be readjusted accordingly. It seems logical that, when a great part of the nation's production and service no longer is needed for the purpose of paying debts abroad, the Government could spend more, and simultaneously the average citizen should be able to increase his standard of living. In effect, this is what the N.P.A. studies tend to indicate.

It is not unnatural to assume that fair-minded and intelligent men can compromise their views; and one may find that a percentage, say, a third, of the so-called gap of $9,000,000,000 will disappear, because in time, due to stability and increased social security, there will be less savings on the part of those who in the past saved for security. One may find that another third will be bridged by increased business activity and exports; and finally, the last third of the gap may be covered by social improvements, health, education, housing, conservation of our national resources, etc.

NATIONAL EMPLOYMENT SITUATION BEING INVESTIGATED

Since issuance of that N.P.A. report,[3] which was designed to clarify some of the directions along which full-employment policies would have to be developed, the nation has gone through several phases of its return to peacetime production. Not the least significant development has been the passage by Congress of the Employment Act of 1946. The Act calls for an "economic report" to be made by the President to Congress on the national employment situation; it sets up a three-man Council of Economic Advisers to assist in the preparation of the report and to formulate economic programs; and it establishes a Joint Congressional Committee on the Economic Report. The National Planning Association co-operates—in an informal way—with the Council of Economic Advisers appointed by the President under the Act. The Council's first report, incidentally, appeared in January, 1947.

This is the first step toward the achievement of an ultimate goal which still may be many years ahead of us. Many mistakes will be made. There are those who doubt that the unemployment problem can be solved at all. Others believe that, if action is taken too quickly, without proper planning, many pitfalls will be faced. All objections and fears have validity.

These are some of the main issues upon which N.P.A. has deliberated and upon which much additional work will be required in the future. Although its efforts have been constructive and useful in the past, it is generally recognized that this organization will likely become increasingly important in the future.

CURRENT PROBLEMS UNDER DISCUSSION

An indication of the urgency of some of the nation's problems may be gleaned from a brief summary of some of the observations and projects discussed at a recent joint meeting of the National Planning Association. Concern was expressed over the future, but there was evidence of a desire to do something about it.

Industrialists were worried about the relationship between increased production and the price-and-wage structure. Retailers were worried about how soon and at what prices they could get goods. Labor and the buying public were hoping for goods to buy, but they were worried about the question of how big the pay envelope would be and how much it would buy. The farmers wondered whether they could produce at full capacity; they wanted to, but they were fearful that if they did and the rest of the economy started to recede, they would be left with a surplus.

It was such fears plus the determination to find a way to overcome them that led to the most constructive single statement which came out of the joint meeting. Agriculture, business, and labor members reaffirmed and strengthened their previous statements in an up-to-date joint declaration called "Goals of Cooperation." That statement calls for teamwork in dealing with day-to-day problems. It seeks to develop an atmosphere in which men can know, respect, and have confidence in one another. It places on agriculture, on business, and on labor clear responsibilities for democratic disciplined leadership. In short, it urges a continuous conference table of citizens, and pledges its signers to work for that continuous conference table.

The men and women meeting together at N.P.A. did not stop, however, with stating the goals. They made a number of specific recommendations on current national issues. For example, they agreed on policies which would enable this country better to meet its responsibilities in the critical world food situation.

They also set additional tasks for themselves on crucial questions for which they did not know the answers. In the field of labor-management relations, three difficult but important studies were initiated as joint projects:

1 A joint subcommittee was instructed to study and recommend the best ways to distribute the gains from increasing productivity. The board and committees authorized this study because they are convinced that the high and steadily rising standard of living of the people of the United States has been due largely to the continued rapid increase in productivity which has characterized our economic system. Labor, management, and the public are in agreement today that continuance of this advance is of the greatest importance to the national welfare.

Industrial relations in the past have been adversely affected by frequent inability of labor and management to agree concerning the distribution of the increased income resulting from gains in productivity. In addition, arriving at the best distribution is vital to the proper functioning of the economy.

N.P.A. believes that the problem of the distribution of gains from increasing productivity has not been studied adequately, and that analysis and recommendations at this time can be fruitful. The governing principles should be that the distribution must be equitable; should produce the greatest total of consumption plus investment; and should lead to continued rapid advance in productivity.

2 Related to the productivity study is another, approved by the members at the joint meeting, on the causes of industrial peace, as differentiated from industrial warfare, under collective bargaining. There is more industrial peace than

most people are aware of because peace is not spectacular or dramatic and people just do not hear of it.

3 Still another project, authorized at the meeting, is a thoroughgoing study of the "annual wage." Annual wages are being widely discussed in the United States by both management and labor. But there are many definitions of what an annual wage means. Some people think it means a year's wage to every worker in a plant or industry. Others think it means an assured amount of work during the year. To others it means a definite agreement by an employer with his workers, providing for specific quantities of work or wages during the year for a specific portion of the workers. N.P.A. plans to investigate as realistically as possible what labor can gain from the annual wage, what business can gain from it, and what it would mean to our economy—not only in terms of employment and wage stability but from the moral and social points of view.

There was unanimous approval by the Agriculture Committee of a report "Dare Farmers Risk Abundance?" which had been in preparation for more than a year. A year ago, as at present, American farmers were being asked to plant and grow foods direly needed domestically, and in war-torn and devastated countries. But even then farmers knew that there would be a day of reckoning when they might have excess production with food rotting on the ground.

Another approach to the nation's future was reported at the joint session. N.P.A. announced the formation of a Committee of the South to work out private and public programs for speeding the development of the vast resources of the southern section of the United States. The development of the South, N.P.A. believes, is a matter of major national policy. It still has a great reservoir of undeveloped resources, untapped markets, and manpower available for jobs in new industries and businesses. The nation cannot attain its goals of continuing high-level employment and production with rising standards of living unless that reservoir is opened. Furthermore, it is the conviction of this association that representative southern leaders, who recognize the interdependence of economic groups and geographical areas in the nation, are best equipped to state the goals and point out the private and public action required for full development of the South's potentialities.

A first meeting of the committee, composed of leaders from the southern area, was held in Alabama on November 21, 1946. Members in attendance included some 50 southerners active in agriculture, business, education, finance, government, industry, labor, and the press. A great deal of unfavorable attention has been given to sectional and racial conflict in the South. But at that meeting—held in the "deep South"—whites and blacks, American Federation of Labor (AFL) and Congress of Industrial Organizations (CIO) members, owners of textile mills and mines, bankers and farmers, teachers and publishers, local and national government officials, sat down together and began mapping out ways to raise incomes and living standards in the South and ways to make the South's full contribution to the nation's progress.

CO-OPERATION THE KEYNOTE TO SUCCESS

In a constantly changing world, democratic machinery must at all times be kept efficient. Co-operation on the part of agriculture, management, business, and labor will be of great help to the Government and to Congress, as well as a great stabilizing influence in the American democracy.

The work of N.P.A. has been approached in this spirit by agriculture, business, and labor, and by leading economists who co-operate in its activities. N.P.A. has had the satisfaction of seeing that many of the studies it has undertaken and many of the questions which it has raised are now more widely understood and have been lifted above ordinary political controversy.

It is well to bear in mind that the underlying philosophy of N.P.A. welcomes all planning organizations. Good work done by others helps this association in its deliberations.

PROGRAM FOR THE FUTURE

The time has come when full employment opportunity for everybody willing to work, adequate social security, adequate nutrition, medical care, a sound fiscal policy, and a sound foreign policy along definite lines, should be lifted above political bickering.

Looking to the future, N.P.A. may well become a balance wheel in the United States democracy in which leaders of agriculture and labor, as well as management and business, will have the opportunity to make their sound views recognized on a national level. It may increasingly leave individual research to other organizations and confine itself more and more to being an assembly plant which, with proper timing, constantly devotes its efforts to planning for the ever-changing needs of the dynamic democracy of the United States.

Applied Mathematics Laboratories

A FEDERAL center of applied mathematics—the National Applied Mathematics Laboratories—has been established as a division of the National Bureau of Standards, according to an announcement by Dr. E. U. Condon, Director of the Bureau.

Organized to conduct research and provide services in the field of applied mathematics, the new organization is oriented around modern mathematical statistics as applied to the physical and engineering sciences and to the development and use of modern high-speed computing. The Applied Mathematics Laboratories include four separate laboratories: the Institute of Numerical Analysis; the Computation Laboratory; the Statistical Engineering Laboratory; and the Machine Development Laboratory.

The concept of such a center originated in 1946 in what is now the Office of Naval Research when it became apparent that there was a strong need for a centralized national computation facility, not only equipped with high-speed computing machinery, but able to contribute to the development of such equipment. Further co-operative study between the Bureau of Standards and the Office of Naval Research indicated that an organization wider in scope than a national computation center was needed. The development of high-speed tools for computation, for example, carried with it an obligation to perform research and conduct training in the theory and disciplines needed for the most effective use of these tools. From the standpoint of both government and private research and industrial processes, the final aim of such a center is to provide the economies and introduce the efficiencies which are possible when relatively inexpensive calculating is substituted for expensive trial-and-error experimentation.

Besides the four laboratories making up the organization, the work is carried on with the advice and guidance of a committee called the Applied Mathematics Council. The Council is made up of representatives of government agencies and private organizations actively interested in the work of the unit.

BRIEFING THE RECORD

Abstracts and Comments Based on Current Periodicals and Events

Compiled and Edited by J. J. Jaklitsch, Jr.

MATERIAL for these pages is assembled from numerous sources and aims to cover a broad range of subject matter. While few quotation marks are used, passages that are directly quoted are obvious from the context and credit to original sources is given.

Education

BECAUSE of the nation's shortage of scientific and technological personnel and the shortage of teachers to train such personnel, Rensselaer Polytechnic Institute, Troy, N. Y., will devote as many of its facilities as necessary to a wide education program for "more and better high-school teachers in science, technology, mathematics, and vocational education."

Under what was described as the only existing program of its kind, R.P.I. will confer two degrees it has not heretofore conferred in its 123 years of existence. They will be bachelor of science in vocational education and master of science in education.

Co-operating in the program are the New York State Department of Education and the State College for Teachers at Albany.

Livingston W. Houston, member A.S.M.E., president of Rensselaer, said that R.P.I. and the two state agencies had decided upon the plan in order to help provide a larger supply of teachers needed to train personnel for the nation's large program for research and development in atomic energy and other scientific advances.

He said that the shortage of operating personnel which could be recruited for these purposes is serious.

This new program would also be of direct benefit to New York State in providing competent teachers for the technical institutes being established in several areas of the state.

Under the plan, students attending the State College for Teachers at Albany, for example, will take courses in engineering, applied science, mathematics, drawing, industrial and technical education, and in more general subjects, by attending evening, Saturday, and summer courses set up at R.P.I. especially for the purpose.

The same courses, on both undergraduate and graduate levels, also will be available for the upgrading of both men and women who are already teaching in schools throughout this state and in others.

U. S. Fuel Economy

A REPORT on fuel economy since 1939, prepared by the United States National Committee for the World Power Conference held at The Hague, Holland, Sept. 2–9, 1947, reveals that during the war the basic conditions requiring fuel economy arose from the diversion of normal supplies to military uses and the greatly expanded requirements of fuel for war industry. Fuel oil and its derivatives were principally affected. Since the end of the war most of the difficulties which were experienced have disappeared, except for the temporary effects of labor disputes and price maladjustments. At present, practically all measures which had been in force to limit the usage of various types of fuel have been eliminated, and efforts to promote the economical utilization of fuel are fundamentally based on the costs and economics involved, rather than on the availability of supplies.

CONDITIONS REQUIRING FUEL ECONOMY

The production of fuels was hampered by shortages in labor and equipment at the source and by the severe dislocation of the normal transportation system. Coal-mining operations were faced by a shortage of manpower due to the draft, strikes, and absenteeism. Further difficulties arose from shortages of equipment and supplies. Crude-oil production was well maintained despite large increases in demand. Refining capacity was tremendously enlarged for 100-octane gasoline, synthetic rubber, and the like, with consequent effects on the availability of domestic and commercial products. Transportation was the major difficulty, requiring a shift from tankers to rail and pipeline distribution and placing a heavy burden on the railroads. Shortages of materials affected drill steels and pipe-line and refinery construction. The principal natural-gas problem was one of transportation, necessitating pipe-line rearrangements to permit delivery to the points of use.

The problem of demand was one of satisfying the increased military demands and of supplying war industries while maintaining adequate supplies for civilian use.

In general, demand for all fuels increased greatly during the 1939–1945 period, with a greater or lesser shortage in all categories. Hydrogenerated electric energy was utilized to a maximum extent, increasing from 44 to 80 billion kwhr during the period.

Price had very little effect on the choice of fuels or on fuel economy during the war period. Availability was the determining factor, with minor exceptions.

ADMINISTRATIVE MEASURES

All petroleum products were under the control of the Petroleum Administrator for War. Coal products were under the control of the Solid Fuels Administrator. The Office of Defense Transportation, through its allocations of transportation facilities, and the Office of Price Administration, through its rationing and price-fixing authority, were the principal co-operating agencies.

All necessary measures were taken to increase production of fuels, such as lengthening the work week, draft exemptions, and expediting supplies and repairs for necessary equipment. For coal, new strip mines were opened, and mining operations were further mechanized. For oil, practically the entire pipeline system was rearranged and additional cross-country lines were built. Hydroelectric generating capacity was added to a maximum extent, and extensive interconnection of electric systems was made to permit greater utilization of hydro resources.

On the east coast, where civilian oil supplies were limited

restrictions were established to shift the use from oil to coal by rationing oil use before rationing coal; by interconnecting electric systems using oil with coal-burning systems to permit shutdown of the former; by limiting the installation of new oil-heating equipment, and the like.

As shortages in civilian coal supplies developed, rationing of solid fuels was resorted to with deliveries restricted for the general consumer to about seven eighths of normal use, while the large users were required to reduce their stockpiles.

Throughout the war period various measures designed to conserve the fuel supply as a whole were in force. These included: Adoption of "war time;" adoption of "brownout," curtailment of use by places of entertainment, and curfew rules; reduction in heating temperatures for public buildings; saving resulting from "dimout" rules; rationing of petroleum products for nonessential driving, motorboats, and similar uses.

TECHNICAL PROBLEMS—PRODUCTION

As a result of increased demands and changing load characteristics, electrical generating equipment, in many systems, was operated for longer periods of time than the equipment was originally designed for, resulting in much higher plant factors. Some of the special problems encountered were as follows: (1) Increased steam temperatures and pressures to the limits set by available metals (950 F) and difficulties with slag in the superheaters (800 F); (2) increased automatic controls, especially under variable-load conditions; (3) higher feedwater temperature; (4) installation of liquefied petroleum facilities for carrying peak loads on gas systems; (5) revision of gas-making methods to recover increased amounts of critical residuals.

New techniques in oil-refining processes and new methods for exploration and bringing in wells were developed. In coal production major developments were salvaging coal formerly rejected and increased mechanization. A program for development of synthetic fuels (alcohol and butanol) from wood was initiated but is still in the pilot-plant stage. Some progress was made in liquefying natural gas at the oil well but much of the gas produced was wasted.

TECHNICAL PROBLEMS—ALTERNATIVE FUELS

Fundamentally, the use of alternative fuels for power generation, gas-making, and in industry, was not extensive. Some progress was made in burning coal-oil mixtures; adapting furnaces for either coal or oil; burning substitutes such as bagasse, water gas, and tar. However, there was a widespread use of inferior grades of coal with the consequent problems of increased ash content. In the domestic and commercial fields, substitution of lower grades of anthracite, admixture with bituminous and reclaimed coke, and shifts from oil-fired to coal-fired equipment were the principal changes. In addition, the oil shortages led to the conversion of many homes to the use of gas for heating.

ECONOMY AND MEASURES FOR INCREASED EFFICIENCY—INDUSTRY, DOMESTIC, AND COMMERCIAL

Boiler-room efficiency decreased during the war, being subordinated to the major problem of production. Over-all turbine-room efficiency likewise was reduced largely because of increased plant factors and utilization of older equipment.

In the domestic field, the trend toward more efficient apparatus, largely interrupted during the war, is expected to continue at a greater rate, with extensive replacement of existing equipment with new and generally more efficient equipment. Examples are the gas-design and oil-design furnaces; mechanical stokers and automatic draft regulators for coal-fired furnaces; home insulation; insulation and storage-heating for gas ranges; improvements in electric-refrigeration equipment; fluorescent lighting. In territory served by hydroelectric power there is an increasing use of electricity for space heating through the use of stored heat during off-peak hours, with a consequent saving in the use of fuels.

The improvements in efficiency are not expected to result in any net savings in fuel consumption, however, since a greatly expanded utilization of apparatus is anticipated for comfort, convenience, and improvements in the standard of living.

DEVELOPMENT OF NEW EQUIPMENT

In so far as conventional equipment is concerned, no radical improvements are expected apart from the items herein noted. New design equipment includes the gas turbine, the hot-air turbine, and the heat pump for cooling and heating. A new process for completely supplying domestic energy requirements by means of a single fuel-burning device utilizing tetracresylicate which boils at 800 F is also being developed.

EDUCATION IN THE USE OF FUEL

Education for efficient utilization in industry, the utilities, and the schools has been a basic element of the educational curriculum and of industrial routines, but has taken on greater importance since the advent of shortages and increases in the relative costs of fuel. The present importance of the subject is indicated by the recent publication of a major work on coal utilization by a group of forty members representing various research and commercial organizations. (Chemistry of Coal Utilization, Division of Chemistry and Chemical Technology, National Research Council.)

New Submarines

AN article in the September-October, 1947, issue of *Ordnance* reveals that the U. S. Navy laid before Congress recently a 4-year plan for the development and exploitation of new types of submarines and surface craft of far-reaching importance.

Concentrating on the potentialities of troop-carrying and cargo-carrying submarines and the development of antisubmarine measures to counter the best in submarine practice, the plan looks particularly to the special needs required by operations in polar waters.

The new program is one of ship conversion so extensive as to amount almost to new construction. It draws importance from the fact that much of it is based on submarine work completed by the Germans just before the end of the war, which was well in advance of anything on the Allied side.

The antisubmarine developments included in this plan will enable the Navy to work up an antisubmarine technique capable of competing with the latest in submarine development. The secrets obtained from Germany were shared with the British and the Russians, the latter having the additional advantage that they occupied the German submarine-building bases and captured many of their builders and designers.

Authorization has been sought to build two troop-carrying submarines, one cargo-carrying submarine, two landing ships (dock), one picket submarine for special Arctic patrol and reconnaissance work, and a general-cargo transport reinforced for work in ice-infested waters, as well as nine destroyers especially equipped for antisubmarine work.

The troop-carrying submarines are expected to be able to carry 100 men fully armed in addition to a crew of about 60.

On July 13 the Navy disclosed that two new experimental submarines—the world's fastest undersea combat craft—would be completed in 1951 and would be radically different from those that sank two thirds of Japan's merchant fleet in World War II.

Congress appropriated $33,000,000 for the vessels and incidental experimental work. They will incorporate secrets known only to the United States Navy, plus secrets captured from the Germans and the Japanese in the war.

They will be named after the wartime submersibles "Tang" and "Trigger."

Hull, machinery, and contract plans are being prepared by the Bureau of Ships and the Portsmouth, N. J., Naval Shipyard. The Tang will be built in Portsmouth and the Trigger in a private yard.

While the Navy is giving no details, it is known that the Germans were working on a submarine at the close of the war which could stay under water for long periods and travel below the surface at 25 to 26 knots. The conventional American submarines can make only about 11 or 12 knots under the surface.

Both ships will carry new-type weapons and more efficient sonar equipment for detecting the enemy.

Vacuum Pressing

TABLET compressing at atmospheric pressure, as in the manufacture of pharmaceutical tablets, mint candies, electrical porcelains, chemicals, sintered carbides, vitamins, food specialties, and other materials and products, is well-established practice. The method is said to have certain limitations, however, especially in feeding and in the compressing of materials in which entrapped air tends to reduce press-operating speeds, or cause laminations, or other defects in pieces produced.

To overcome the difficulties of atmospheric compressing the F. J. Stokes Machine Co. is reported to have developed a new machine and technique in which compressing is done under vacuum pressures which are varied to meet conditions. This press applies a maximum of 20 tons' pressure from above and below, has a die fill of $2^{5}/_{8}$ in., and will produce pieces up to 3 in. in diameter.

Pressure from above is exerted by means of an adjustable eccentric crank and on the lower punch by cam action. A vacuum chamber surrounds the die table, the punches, and the feeding device. The feed hopper, with vacuum cover, is attached to the top of the vacuum chamber and a receptacle under vacuum receives the finished parts at the side of the main vacuum chamber. Special stuffing boxes seal the upper and lower plungers where they enter the chamber.

The parts receptacle is large enough to hold all pieces produced from one full charge of the hopper. A vacuum pump can be supplied. Several of these presses are in actual service and one is available in the Stokes laboratory for testing various materials under different conditions and at vacuums to within a few millimeters of absolute pressure.

All the possibilities of this new technique have not been explored, but sufficient factual information has been developed to indicate the process should have a wide application. Advantages claimed for vacuum compressing as compared with atmospheric compressing are as follows: Elimination of air produces pieces which would ordinarily laminate due to air cracks; material feeds more freely; generally less depth of fill is required because of increased density of loose powders; conversely, thicker pieces can usually be produced with a given depth of fill; press speeds can be stepped up; savings in material costs can sometimes be made by reducing the quantity of binder; a high degree of uniformity in granulations is not required; there being no air in the chamber, no "puffing" can occur as the upper punch enters the die; there is little or no loss in material and no soft spots occur at the edges of the piece; operation is cleaner, with less dispersion of fine dust and resulting wear on machine parts.

Tests are being conducted on metal powders, carbon mixes, sintered carbides, ceramic tile, and other applications for which this new technique seems to offer possibilities.

Electronic Timer

A NEW electronic timer, particularly adapted for use with a falling-ball viscosimeter in the study of the rapidly changing viscosity of an opaque fluid, has been designed by P. J. Franklin of the National Bureau of Standards. The device consists of pulse-sharpening and trigger circuits, and the passage of the ball through two coils around the viscosimeter tube is used to trigger a radio-frequency oscillator, starting and stopping a timing device.

In measuring viscosity by the falling-ball method, a closed tube, surrounded by a constant-temperature jacket and containing a ball immersed in the liquid to be studied, is quickly inverted. See Fig. 1. Viscosity is determined from the rate of descent of the ball through the liquid, and this requires accurate timing, which the electronic timer provides. The method is very useful for viscosity measurements in many industries, for example, in the production of paints and lacquers where the instrument must be enclosed to prevent evaporation of volatile solvents. The falling-ball viscosimeter is also used in the oil and asphalt industries. Here the opacity of the liquids involved makes nonvisual timing a necessity. For similar reasons, viscosity measurements of catsups, jams, jellies, and other foods are perhaps most efficiently carried out with a falling-ball apparatus equipped for electronic timing.

A comparatively simple circuit, Fig. 2, was developed for the timer, making use of the radio-frequency induction field. The output of a 1400-kc crystal oscillator is link-coupled to the start and stop coils surrounding the viscosimeter tube. No buffer amplifier is required. A small padding condenser is placed across each coil, so that the amount of detuning is the same in both coils as a steel ball falls through them, changing the inductance of each coil in turn.

The radio-frequency power from each coil is rectified in the separate diodes of a 6SQ7 tube, and the resulting change in cathode current is amplified in the triode portion of the tube to obtain sufficient voltage variation to operate a pulse-sharpening circuit consisting of two 0.04-watt neon bulbs in series with a

FIG. 1 PHOTOGRAPH ILLUSTRATING THE TIMING OF A FALLING-BALL VISCOSIMETER BY MEANS OF THE NEW ELECTRONIC TIMER

load resistor. When the voltage in the plate circuit of the amplifier rises to the ignition point of the neon tubes, the neons suddenly fire and a sharp pulse is produced across the load resistor. These tubes have a small amount of radium added to provide uniform ignition voltage regardless of illumination. Furthermore, they have the advantage that once ignited they stay ignited until the output voltage of the triodes has dropped to a low value, allowing only one pulse to occur with the passage of the ball through each coil. Both pulses are placed on the grids of a trigger pair, which on the first pulse closes a relay that starts a clock and on the second pulse opens the relay to stop the clock. Time of fall, as measured with this circuit for one direction of travel, was found to be reproducible within 0.01 sec for a fall time of 2.5 sec.

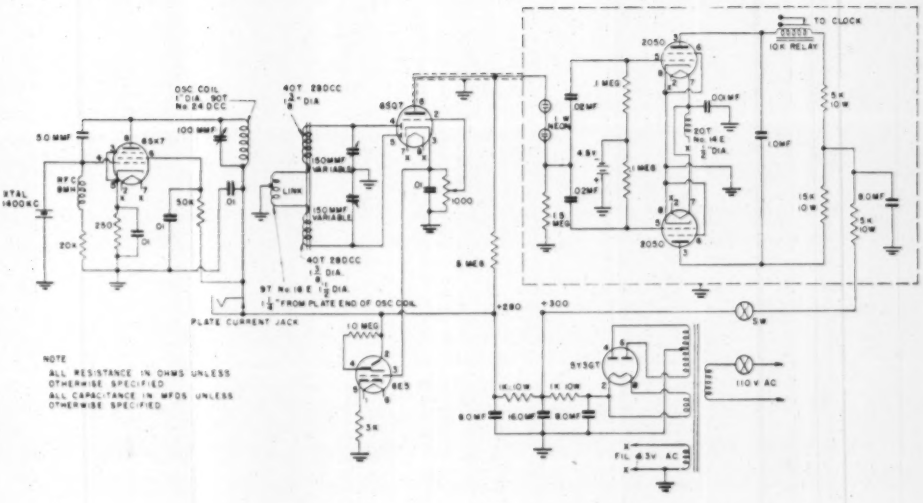


FIG. 2 CIRCUIT DIAGRAM FOR ELECTRONIC TIMER FOR VISCOSITY MEASUREMENTS

The electronic timer was designed for a process requiring repeated measurement of the viscosity of an opaque liquid held within a limited temperature range.

Apprentice Training

THAT 96,000 establishments are now participating in 25,400 apprenticeship programs was revealed recently in an address by William F. Patterson, director, Apprentice-Training Service, U. S. Department of Labor, before the annual convention in Cincinnati, Ohio, of the Metal Polishers, Buffers, Platers, and Helpers International Union.

This high mark in the number of establishments now training apprentices, which was reached in June, was a gain of nearly 80 per cent over the number recorded for June of last year, Mr. Patterson pointed out. It was a 167 per cent gain in programs established.

He stated that while the construction industry has made extraordinary progress during the past 12 months in establishing apprentice-training programs to supply the craftsmen needed for housing and other building projects, the metalworking industry has been equally active in the development of its much-needed skilled workers. Individual-plant apprenticeship programs, which are mostly in the metalworking trades, tripled during the year.

The records of the different states reveal that Ohio now leads the nation in the total number of programs as well as in the number of programs set up in individual plants, while California leads in the number of areawide programs and the total number of participating establishments. Among the close competitors of these two states in apprenticeship activities, are Pennsylvania, Wisconsin, Michigan, Illinois, New York, Texas, and Virginia.

Attention was called to the fact that 1947 is the tenth anniversary since the enactment of the national apprenticeship law; and of the establishment under that law of Apprentice Training Service and the Federal Committee on Apprenticeship, the national joint management-labor policy-making body on apprentice training. The national law known as the Fitzgerald Act, was passed by Congress in 1937 ". . . to promote the furtherance of labor standards of apprenticeship . . ." and ". . . to bring together employers and labor for the formulation of programs of apprenticeship."

Although the national apprenticeship program has been through many vicissitudes since the enactment of the Fitzgerald Act, the accumulated records of Apprentice Training Service show an amazing response on the part of employers and labor in carrying out the objectives which are sought by that legislation.

In conclusion, it was recommended that the metalworking industry follow the example of the construction industry in the adoption of national standards of apprenticeship in each trade for the guidance of employers and labor unions in every locality. National standards have been helpful to local groups in the construction industry, and this plan should be equally helpful in the metalworking industry. It would greatly facilitate the setting up of apprenticeship programs, clarify procedure, and eliminate many of the questions which arise in establishing and conducting programs.

Radioactivity

ALTHOUGH radioactivity still is present on Bikini atoll, site of the 1946 atomic-bomb tests, human beings could reside on the atoll without danger, at least for a brief period of time.

This is the opinion of Dr. William H. Hamill and Dr. Russell R. Williams, Jr., professors of chemistry at the University of Notre Dame, who returned on September 4 to Notre Dame after serving as special consultants to the United States Navy in atomic research studies conducted this summer at Bikini to determine conditions on the atoll one year after the bomb experiments.

Both Dr. Hamill and Dr. Williams, who were concerned in their investigations with the radiochemical effects on the atmosphere, agreed that there is still much radioactivity at Bikini, but that the activity is thoroughly distributed among the biological deposits and is not concentrated in one location.

The two scientists said that human beings could live on the atoll briefly—even possibly for a period of a year—without suffering ill effects from the radioactivity present at Bikini. They pointed out that water life, such as fish, contain radioactivity, but that a person eating only a few of the fish would

not be affected, and that the same condition is true of coconuts growing on the atoll.

Drs. Williams and Hamill reported that divers went 200 ft below the surface to study the radioactivity aboard ships sunk by the test blasts. These divers labored under difficult conditions, however, since at that depth they were able to work only 20 minutes at the bottom while taking about four hours to rise to the surface because of necessary decompression processes.

In order to facilitate the difficult process, underwater television was used for the first time and underwater photography also was utilized.

They added that during the early studies at Bikini strict precautions were taken to protect the scientists against any existing radioactivity. Water from the lagoon was not used for drinking nor was any swimming permitted in the lagoon. When it became apparent, however, that the radioactivity was not concentrated enough to cause human damage, these restrictions were relaxed. During the entire five weeks on the atoll, however, the scientists were not permitted to eat any of the seafood from the lagoon or any of the coconuts growing on the atoll.

The select group of scientists on the expedition included 60 civilian scientists and 20 technical personnel of the Army and Navy.

Metals Comparator

METAL parts and stocks appearing alike but differing in composition are reported to be quickly and easily separated with a new metals comparator developed in the General Engineering and Consulting Laboratory of the General Electric Company. The operation of the instrument, which employs a balancing electric network, is said to be nondestructive and can be carried out effectively for either magnetic or nonmagnetic materials. Thus far the comparator has been used to differentiate between annealed and unannealed steel bars, and also to sort finished metal parts, on the basis of composition or heat-treatment. Ferrous metals have been sorted on the basis of average hardness.

FIG. 3 SORTING STOCK BY MEANS OF METALS COMPARATOR

In operation the piece to be tested is inserted in the center of a small solenoid forming one leg of a balanced circuit, the other leg of which is a variable resistance. Before this is done the circuit is balanced with a reference specimen inside the solenoid. If the piece being tested is identical with the standard specimen, the circuit will again be balanced. If the chemical and physical properties of the reference and sample are not identical, their electric and magnetic properties will be different. Under these circumstances the impedence of the solenoid will not be the same and the circuit will be unbalanced, a condition that can be read on a microammeter. After establishing tolerances for microammeter readings, specimens can be accepted or rejected on the basis of the dial reading. As many as 1500 small parts can be tested per hour.

The equipment is designed for operation from an ordinary 60-cycle 115-volt commercial power supply. Test coils of different sizes are available, ranging from $^1/_2$ to 3 in. inside diameter. Leads are of convenient length so specimens can be tested in any position adjacent to the instrument.

Acceleration Machine

A NEW machine now being built by the Navy will subject aircraft pilots and instruments to high accelerations, equivalent to those experienced when flying military aircraft. It will be considerably larger than machines now in use for this purpose.

Powered by an electric drive system developed by General Electric engineers, the new accelerator will provide radial accelerations up to 1290 ft/sec^2 or 40 times the acceleration of gravity. The rotating system will be driven directly by a vertical motor rated 4000 hp and capable of developing a maximum torque of 1,700,000 lb-ft.

Acceleration patterns of aircraft in flight maneuvers will be simulated by the drive, which utilizes an amplidyne exciter in combination with an electronic control system which in turn will be responsive to a program control. Emergency stopping will be accomplished by dynamic braking, the machine being brought to a final halt by pneumatically operated friction brakes.

Flame-Cutting Stainless Steel

FABRICATION by flame-cutting and welding is commonplace in mild-steel work; but for stainless steels, the fundamental advantages of using the two methods in combination is reported to have only recently become fully available through the introduction of a method of flame-cutting the high alloys—the "Flux-Injection" method—recently developed by the Air Reduction Company.

The new method is said to solve the problem of flame-cutting stainless with a special dry nonmetallic flux, carried directly by the cutting-oxygen stream, to cope with the refractory oxides formed by the alloying elements, which stop the cut in normal oxyacetylene practice. The flux-bearing oxygen emerges through a standard-style tip to effect the cut, and the only special equipment required is the compact and portable flux feeder unit. Speeds, costs, and quality are claimed to compare favorably with the standards of mild-steel work. When it is considered that the only previous alternative for comparable results was machining, the inherent savings for stainless fabrication work are apparent. A case in point was the construction of a 12-ft stainless and nickel-clad base for a Hydrapulper machine designed to reduce reclaimed paper and

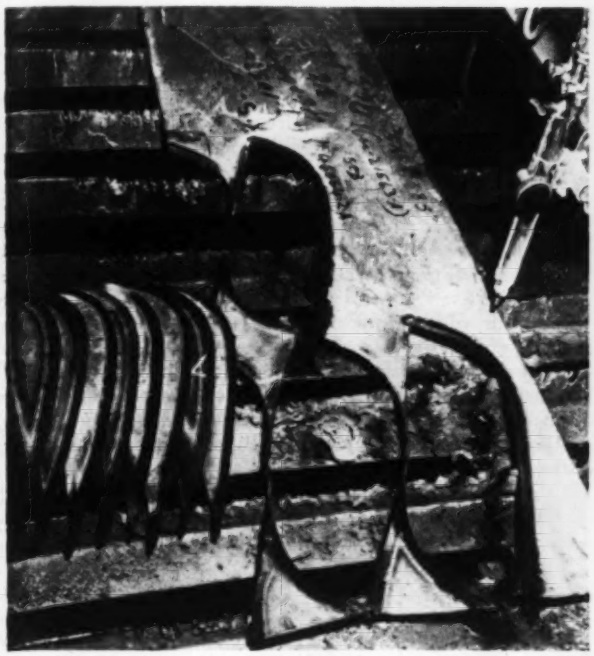


FIG. 4 EIGHT VANES HAVE BEEN FINISH-CUT IN THIS VIEW AND BOTH THE CURVED EDGE, FOR WELDING, AND THE STRAIGHT EDGE, WHICH IS NOT TO BE WELDED, SHOW GOOD QUALITY

(Average cutting time per piece was under two minutes and good layout reduced scrap loss to a minimum for further savings.)

FIG. 5 MANY OF THE PARTS FOR THE ALL-WELDED BASE UNIT WERE FLUX-INJECTION CUT

(1, Flanged periphery of head; 2, adjacent inner rings, removed by Flux-Injection, cut into radial segments, and drilled, to form extractor plates; 3, bearing ring for rotor; 4, stainless vanes, finish-cut by Flux-Injection and welded to nickel cladding; 5, one half of tub wall, separately fabricated of nickel-clad, in position for checking alignment and fit-up.)

virgin pulp to slush-form suitable for the paper-making machines. The material is both highly abrasive, and with its admixtures, corrosive, and the most advantageous materials for these operating conditions were chosen—nickel-clad steel, or chrome-nickel stainless, depending upon whether one or all surfaces would be exposed.

Flux-injection cutting was used for both materials. The most important stainless parts were the vanes which, while only about one foot long, were required in quantity. They were cut readily and quickly on a standard oxygraph to finish dimension, even on the edge which was not to be welded, Fig. 4.

For the nickel-clad parts of the unit, flux injection was also used to obtain the best dimensional accuracy and utmost protection for the cladding. Where, in ordinary oxyacetylene practice on this material the cut would proceed from the mild-steel side, with considerable risk of separation or melting away of the cladding, the cuts were made with flux injection from the nickel side. The cladding remained intact, and the resulting edge was said to be in excellent condition for welding. Most of the nickel-clad cutting was done on a 12-ft flanged head produced by the Lukens Steel Company, and the work was so designed that there was virtually no scrap loss from this head. See Fig. 5.

Sides for the tub, Fig. 5, which rest on the top rim of the base unit, were fabricated from Lukens Clad, rolled to semi-cylindrical shape, with external stiffeners attached. The fourth subassembly of the machine was a rotor, cast in 3 per cent nickel-alloy cast iron. Thus the entire machine was shipped to the erection site in only four main parts, saving time and space, and erection was greatly simplified. The finished machine is corrosion-proof, abrasion-resistant, rigid, and has a minimum of parts which can loosen under vibration. Since the seams are welded watertight, calking has been eliminated, along with other maintenance problems. Although the fundamental design of the machine is not new, its all-welded corrosion-resistant structure, simplified design, and generally improved qualities, represents a new high standard for the line, which, without such an innovation as flux injection cutting to reduce construction costs, might not have been economically feasible.

Coal Hydrogenation

COAL hydrogenation, an old process for converting coal to gas and oil, was first introduced in Germany and is generally credited to Friedrich Bergius, according to an article by C. A. Scarlott, appearing in the *Westinghouse Engineer* for September, 1947. Although it was announced in 1913, its development was slow. Not until the early twenties did the process reach the pilot-plant stage. However, by the outbreak of the war 18 plants were producing at the maximum yearly rate of four million tons or about 28 million barrels of high-octane synthetic gasoline and other synthetic products from coal and tar. This was about six times that produced synthetically in Germany by the Fischer-Tropsch process and one fourth Germany's total oil supply. England too had a coal-hydrogenation plant at Billingham, erected in 1935, with a capacity of about a million barrels of motor fuel annually.

Coal hydrogenation essentially follows the direct procedure of making up coal's deficit of hydrogen by breaking down the complex coal structure and adding hydrogen before the fragments can reform. Pulverized coal is mixed with equal parts of a heavy oil obtained from the process to form a paste. The paste, to which is added a small amount of catalyst, is pumped along with hydrogen to a high-pressure reactor or converter. The process is characterized by the pressure and temperature

reached in the cycle: 800 to 900 F and 3000 to 10,000 psi, the pressure depending on the kind of coal used and the cost and availability of catalyst. The light and middle oils formed in the converter are separated from the heavy oil by distillation and are carried, along with the excess hydrogen and hydrocarbon gases formed in the reaction, into a heat-exchange and condenser system. Subsequently the oils are separated from the gases. The gases are scrubbed with oil under pressure to remove the bulk of the hydrocarbons, and the residual hydrogen is recycled to the preheater.

The heavy oil contains in suspension the ash-forming constituents and unreacted coal particles. About two thirds of this slurry is directly recycled to the paste-preparation system, whereas the remaining third is centrifuged to remove a portion of its solids. The centrifuge oil and the oil recovered by a coking distillation of the centrifuge solids are recycled to the paste-preparation system.

The light and middle oils are separated into three fractions: gasoline, middle oil, and heavy oil. The last is recycled to paste preparation. The gasoline fraction obtained in this first stage or liquid phase constitutes about 27 per cent of the total gasoline yield and is of about 72 octane number before the addition of tetraethyl lead.

The middle oil from the liquid phase is pumped with hydrogen at 3000 psi, through a preheater into the vapor-phase converters filled with catalyst pellets. In passage over these catalysts the middle oil reacts with hydrogen to form water, ammonia, gasoline, and lower boiling hydrocarbons, such as butane, propane, ethane, and methane. The gasoline thus obtained has a high-octane rating.

The proportion of solid residues, oils, and gaseous hydrocarbons resulting from the hydrogenation is controllable over a wide range by the temperatures at which the reaction is allowed to occur and its duration. The over-all thermal efficiency of the coal-hydrogenation process for gasoline production in Germany was about 28 per cent but the U. S. Bureau of Mines estimates this can be substantially increased, perhaps as much as doubled.

Unlike gas synthesis, hydrogenation has not been chosen for a commercial plant in the United States as yet. However, it has been under extensive study by the Bureau of Mines for nearly ten years and the research is being actively continued.

British Aircraft Display

A LARGE variety of airplanes ranging from single-seat primary gliders to 60-seat airliners, from elementary three-seat military trainers to 600-mph jet fighters and heavy long-range bombers—as well as raw materials and every category of instrument and accessory equipment—were shown at a flying display and exhibition sponsored by the Society of British Aircraft Constructors. The display was held at Radlett Airfield, near London, England, September 9–11, and was attended by approximately 10,000 visitors from nearly 50 different countries. Visitors were free to inspect some 70 different airplanes, or to study and examine the exhibits shown on approximately 190 stands.

The show marked the first appearance of the Hermes II, a large experimental four-engined airliner said to embody features making for the highest possible standard of passenger comfort, convenience, and safety. It has spacious and airy interiors, large windows, pressurized and air-conditioned cabins, and many other luxuries.

One of the new light airplanes shown for the first time was the Heston A. 2/45, a two-seater "artillery observation post." To achieve all-round view, particularly from air to ground, the designer adopted a pusher propeller layout with a low wing. Tail surfaces are carried on a pair of tail booms, an arrangement which puts crew stations ahead of the wing. The nacelle, where the crew is housed, has been kept narrow, while the transport cabin canopy bulges outward. With a view like this, little that happens on the ground or in the air is hidden from the crew.

Among the airplanes which were demonstrated was the "Ghost" Lancastrian which is being used as a flying test bed by the de Havilland company for the flight-testing and general development of their "Ghost" jet engine, claimed to be one of the most powerful in the world. A description of the Ghost gas-turbine engine appear in MECHANICAL ENGINEERING, September, 1947, pp. 765 and 766.

From the tests made with two such flying test beds, it will be possible to obtain flight data about fuel consumption, performance, temperatures, and reliability of the Ghost engine. While much useful information will be gained from the first of these adapted Lancastrians, the Ghosts installed in the outboard positions of the second aircraft will closely simulate those with which the de Havilland D.H. 106 airliner will be powered, with similar accessories and cabin blower arrangement.

The Lancastrian's two Ghost engines have already completed more than 25 hr of flying, and after stripping, inspection showed that their internal condition was extremely good. Technicians are aiming at achieving 240 hr between engine overhauls in order to make jet engines a sound proposition for the commercial operator and there are high hopes that such a reliability factor will be achieved.

A novelty of an unusual kind was provided by the Miles M.68 which, taking off for its demonstration, landed almost at once, detached its freight-hold, then took off again without it. In this design, the freight-hold takes the form of a two-wheeled road trailer which, once loaded, need not be opened until it reaches its final destination. The goods therefore suffer no damage from being transferred from one vehicle to another on the journey.

Details of the Hastings, previously secret, were also revealed at the show. Largest and fastest of British transports, it has a top speed of 354 mph and can cruise at over 300 mph for more than 3000 miles. Its multipurpose roles include freighter, paratrooper, ambulance, troop-transport, supply-dropping, and glider-towing. The capacious fuselage can carry up to 7½ tons.

The Hastings is a military counterpart of the civil Hermes and is suitably modified internally, as well as having a large freight door to allow a variety of military vehicles and other bulky equipment to be loaded up the special ramp which can be carried inside the airplane.

A new British propeller-turbine engine, now off the secret list, is the Napier "Naiad". Rated at 1500 hp, it drives a propeller while obtaining additional thrust from the exhaust gases in the manner of a normal jet engine.

The air enters through the hollow spinner, passes through an axial compressor, and is then mixed with fuel and ignited in five combustion chambers. The heated products turn a turbine which drives the compressor and the propeller and are expelled from the rear as a jet. It is 28 in. in diameter and 8 ft 6 in. long.

In another demonstration, a passenger, with his seat and parachute, was ejected clear of a two-seat Gloster "Meteor" jet fighter flying at more than 500 mph. At an altitude of 12,000 ft he pushed back the cockpit canopy, then pulled a canvas curtain over his face from a framework attached to the back of the seat. The curtain protected his face from the impact of the air. A tug on the curtain fired the cartridge and he was rocketed upward with his seat. A small drogue parachute

steadied his seat, then he pulled his parachute rip cord and floated safely to earth.

This ejector seat has been adopted by the Royal Air Force as standard equipment on high-speed fighters.

Two helicopters—the Cierva Autogiro Company's W.9, which was built purely for experiment, and the Fairey Gyrodyne—attracted much attention. The W.9 uses reactive forces to counteract rotor torque; the Gyrodyne has a small airscrew mounted on a stub wing and driven from the engine by gearing. Both are said to be new approaches to the rotor torque problem.

Viewed as a whole, the 1947 display demonstrated that the British aircraft industry has picked up the broken threads of civil design and construction, and the aircraft now in production and on test have about them all that is new in aircraft practice.

It was estimated that British exports from the aircraft industry this year will exceed £20,000,000 in value. The number of inquiries at Radlett, as well as firm and tentative orders already on hand, indicate that the volume of overseas trade done by United Kingdom aircraft and allied companies, and their overseas associates, will reach a new high level.

Simplified Oxygen Plant

TO satisfy the requirements of firms in Russia situated away from main industrial centers, it was decided to design a small oxygen producing plant, to give an output of 175 cu ft per hr, which could be manufactured in a small works.

An abstract, describing the plant, appears in the August, 1947, issue of *The Engineers' Digest*. The original article was published in *Vestnik Mashinostroenia*, No. 2/3, 1946, and was written by S. Y. Gersh.

The standard Russian 6-cylinder truck engine Z.I.S.-5 was converted to function as a four-stage compressor, using two cylinders for each of the first two stages of compression and the other two cylinders for the remaining two stages. The first four cylinders of the engine are used complete with pistons and connecting rods, and the other two cylinders are adapted with new final stage compressor cylinders in which pistons and rods are reciprocated by the standard connecting rods and pistons operating as crossheads. In all cylinders the valves are of a combined ring and spring-plate type and are identical for the first two stages except for the strength of the springs. The new cylinders and cylinder heads are of fabricated construction.

Using the existing engine crankshaft the stroke is $4^1/_2$ in., while the cylinder diameters are 4 in. for stages one and two, 2 in. for stage three, and 1.2 in. for stage four. To deal with 2000 cu ft of air per hr at 500 rpm an 18-kw drive is used, and the pressure required at starting is 200 atm dropping later to about 80 atm.

The air is drawn through a cleansing filter into the compressor, with cooling at each stage, and the CO_2 is removed between stages two and three. After leaving the cooler it is dried by passing through dry caustic soda, or silica gel containers and then passes to the oxygen-producing apparatus.

The filter is of the Raschig ring type, the oil being a mixture of 60 per cent cylinder and 40 per cent solar oils.

The CO_2 remover is a vessel 18 in. in diameter × 6 ft 6 in. high, containing a 10-in. pipe with Raschig rings. It is designed for a pressure of 15 atm, and the reagent used is caustic-soda dye.

In the oxygen-producing apparatus the air passes through a cooler at the top, through a cooling coil in the bottom liquid-air container where it is liquefied at the expense of the heat of evaporation of liquid oxygen, and then through a reducing valve where its pressure is reduced to about 6 atm. After this the separating process takes place.

Some of the vapor from the liquid-oxygen evaporation rises through a column of Raschig rings, made of small copper tubes, and enriches the liquefied air with oxygen, while the vapor is enriched with nitrogen, until 88 per cent becomes nitrogen gas which is reduced to a pressure of 1 atm and passed out of the system. The remaining liquid reaches the bottom container as 99 per cent pure oxygen, is evaporated by the heat of the incoming compressed air, and is drawn off, also through the upper cooler, to a receiver. The upper cooler contains six coils wound together of which five are for incoming air and one for outgoing oxygen while the surrounding medium is for the outgoing nitrogen. The producing apparatus is 8 ft long × 19 in. in diameter, and is enclosed in a sheet-steel outer casing.

The energy used in this small-scale installation is necessarily rather high, being about 0.1 kw per cu ft of oxygen gas at 6 atm.

If it is more convenient to store the gas at higher pressures, a separate compressor must be used. On the other hand, if lower pressures are acceptable the yield of oxygen improves because the producer works more efficiently.

The plant is small enough to be portable and is intended to be used in this way for constructional work in the field. In such cases the engine of the transporting lorry can also be used to supply the motive power for the plant.

Astronomical Research

THE measuring engine of the Yale University Observatory, utilized to study the extremely large photographic plates employed in scanning the heavens, is now being used to check an important phase of the Brazilian sun eclipse to furnish new data on Einstein's famous theory about the curvature of light.

George Van Biesbroeck, professor-emeritus of astronomy at the University of Chicago, is now in New Haven, Conn., to use the Yale measuring device, since it is one of the few existing instruments which can handle his large square photographic plates. His plates are sheets of plate glass, measuring 17 × 17 in., and coated with a red sensitive emulsion.

The photography took place during the total eclipse of the sun on May 20 in a camp set up by the Army Air Forces near the little town of Bocajuva, about 400 miles north of Rio de Janeiro. The expedition was a joint enterprise of the National Geographic Society of Washington and the Air Forces.

The particular purpose of Professor Van Biesbroeck's observations was to measure the well-known "Einstein shift." When an eclipse occurs, the effect of the sun's mass causes a curvature in the path of light coming from the stars by which a star's image is displaced away from the center of the sun by a slight amount.

Since the first test of this phenomenon was made by the late Professor Eddington in 1919, many astronomers have made determinations. The results, in general, have confirmed the Einstein theory but the amount of the shift has differed appreciably in various astronomical expeditions.

Professor Van Biesbroeck reports that the observations are extremely delicate and the question at issue is of sufficient importance to warrant making special efforts to eliminate possible weaknesses that might have affected previous analyses.

One improvement which he introduced is the method of photographing two points in the heavens simultaneously, the star field surrounding the sun and a distant star field brought into the camera by a reflection device.

In August, the astronomer made a second trip to Brazil to photograph the same star field during the night. For this purpose the camera had been left in precisely the same position it was in during the actual eclipse in May.

The Army Air Forces made meteorological investigations during the eclipse. One criticism against previous measurements of the Einstein shift was that the shadow cone of the moon might cause refractions which, if large enough, cou'd lead to erroneous interpretations. By making these weather readings during the eclipse, this possible uncertainty has been removed by Professor Van Biesbroeck.

Temperatures were measured at the telescope and up to heights of 100 ft. Balloon flights with recording instruments went to heights of 20,000 and 30,000 ft to complete the temperature readings. Approximately 60 men of the Army Air Forces aided the astronomical research in Brazil.

Steam-Electric Power Plant

A PAPER covering briefly the history, design, construction, and operation of a steam-electric power plant to furnish electric energy for the mining and milling operations of the Kennicott Copper Corporation, Utah Copper Division, was presented at a Power Division session during the Fall Meeting, Salt Lake City, Utah, September 1–4, 1947, of A.S.M.E., by George A. Parker, member A.S.M.E., assistant mechanical engineer of the company.

Work commenced on the design of the plant and the selection and ordering of equipment in May, 1941. Ground was broken in October of the same year, and the design and construction proceeded simultaneously from the latter date.

The plant as originally designed consisted of three 25,000-kw and two 5000-kw turbine generators, three boilers each having steaming capacities of 350,000 lb per hr, together with necessary auxiliary equipment.

Because of the limitation of materials caused by wartime shortages, the War Production Board appropriated the three partially fabricated 25,000-kw and two 5000-kw turbine-generator units and one of the three boilers, and substituted one 50,000-kw turbine-generator unit which was in the process of fabrication for a public utility company. This change necessitated radical changes in the design and added materially to the cost of the plant.

The plant with two boilers and one 50,000-kw turbine generator was completed and put into service in April, 1944, and since that time has generated the power for the two mills at Magna and Arthur.

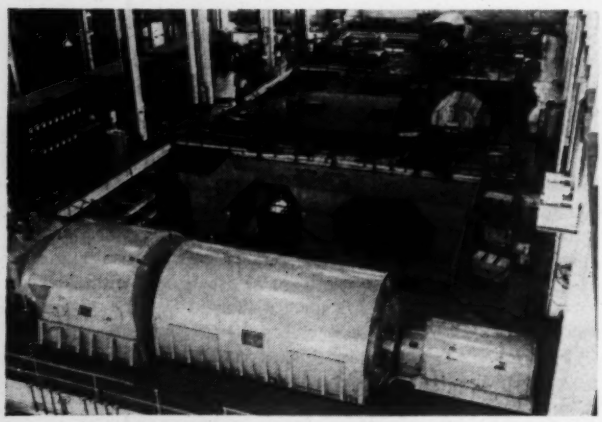


FIG. 6 INTERIOR OF PLANT LOOKING DOWN ON THE OPERATING FLOOR

(The 50,000-kw turbine generator, now operating, is in the foreground. The two 25,000-kw units are shown in different stages of erection.)

FIG. 7 GENERAL VIEW OF THE CENTRAL POWER STATION, SHOWING IN THE FOREGROUND THE COAL-UNLOADING STATION, COAL-CONVEYER GALLERY, AND A REAR VIEW OF THE 48-CELL COOLING TOWER

At present, work is progressing on the installation of two 25,000-kw turbine generators and one boiler together with the necessary additional auxiliary equipment.

The unique features of the plant are as follows: (1) The building is large and spacious with ample room around all equipment for ease of erection, operation, maintenance, and installation of future equipment when and if desired. (2) The removal of condensate from the condensers is accomplished by means of a barometric drain. (3) The supply of water for all purposes being extremely limited necessitated the installation of cooling towers so that all cooling water for condensers and other equipment could be recirculated with a minimum of loss. A 48-cell forced-draft cooling tower for cooling 95,000 gpm from 90 F to 77 F with a wet-bulb temperature of 58 F was installed to serve the condensers on the prime movers, and a 3-cell tower of duplicate construction to supply cooling water for other station service such as air coolers, hydrogen coolers, oil coolers, bearings, and the like.

The boilers are of the radiant water-tube type, designed for 950 psig and are operated at 900 psig in the drums. They deliver steam through a complete header system to the turbines at 850 psig 900 F at the turbine throttles. The turbines operate with a vacuum of $1\frac{1}{2}$ in. Hg in the condensers.

Each boiler is fitted with one motor-driven vane-controlled forced-draft fan and one induced-draft fan motor-driven through a hydraulic coupling for speed control. An auxiliary induced-draft fan, without hydraulic coupling, will serve either boiler No. 1 or No. 2 in case the principal fans require shutting down for inspection or repair. A second auxiliary induced-draft fan serves No. 3 or a fourth boiler when and if installed. Each boiler is served by a separate concrete stack.

Each boiler is fitted with six forced-draft cross-tube-type burners for burning natural gas or pulverized coal or both fuels simultaneously. Three coal pulverizers serve each boiler. Natural gas is burned as the primary fuel and pulverized coal as stand-by fuel. Ash is removed from the furnaces as a molten slag. During the coldest weather, the supply of gas is insufficient for the plant demands because of increased domestic demands and the limited capacity of the pipe line bringing the gas from the Wyoming fields.

The turbine-generator unit now in service is a 50,000-kw 0.8-pf 13,800-volt 3600-rpm hydrogen-cooled tandem compound double-flow turbine generator set with gear-driven exciter and pilot exciter. The two units now being installed are each a

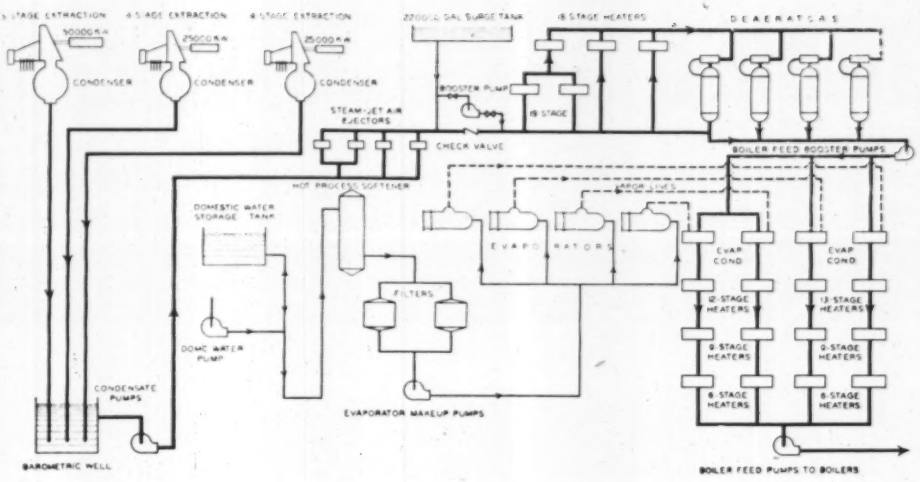


FIG. 8 FLOW DIAGRAM FOR CONDENSATE AND BOILER FEEDWATER

25,000-kw 0.7-pf 13,800-volt 3600-rpm hydrogen-cooled single-cylinder turbine generator set with direct-driven exciter and pilot exciter. These 0.7-pf generators can carry a continuous load of 31,250-kw with a 0.875-pf in effect on the company's system.

The 50,000-kw turbine generator unit is served by a 50,000-sq ft horizontal single-pass divided water-box-type surface condenser which is protected by two 30-in. atmospheric valves. The two 25,000-kw units are each to be served by a 20,000-sq ft condenser of similar design protected by low vacuum trips and rupture diaphragms on the turbines.

Four boiler-feed-pump units, one steam-turbine-driven and three motor-driven were provided. Each unit consists of one No. 5HT 4-stage boiler feed pump and one No. 4GT 2-stage booster pump mounted on a common shaft and bed plate and driven by a single 1000-hp motor or turbine. Each unit has a capacity of 500,000 lb. of water per hr against a total head of 1300 psig.

The design of the station piping includes complete header systems so that any boiler or boilers or any piece of auxiliary equipment except closed feedwater heaters, evaporators, and evaporator condensers can be operated in connection with any one or any combination of turbine-generator units.

The water and water-treating systems consist of the boiler-water system, the condenser cooling-water system, and the station-service cooling-water system. Water conditions in all parts of all systems are checked twice daily or more often by chemists in the station's water-testing laboratory.

Fig. 8 is a flow diagram for the condensate and boiler feedwater.

All make-up to the boiler-water system is condensate supplied by submerged-coil single-effect evaporators, one of which is located in each of the four heater-bank sections. Steam for the evaporators is bled from the turbines from either the high pressure or low pressure stages depending on the make-up requirements.

Make-up to the evaporators is artesian-well water presoftened in a lime-soda-ash type hot-process softener. Because the raw water carries nearly 1000 ppm dissolved solids, it has been necessary to maintain heavy blowdown from the evaporators. In order to maintain the total dissolved-solids content in the evaporator brine at 2000 ppm or below, evaporator blowdown amounts to about 50 per cent of the volume of output and the evaporators are sized accordingly.

A flow diagram for the cooling water for condensers and station services is given in Fig. 9.

The condenser cooling-water system consists of a treating plant, 8,000,000-gal storage vats for treated effluent, a battery of forced-draft cooling towers having large "basins" for additional storage, and the necessary pumps and supply and return headers to serve the condensers.

Make-up to the condenser cooling-water system comes from Utah Lake via a 30-mile open canal during the summer months. During the winter months water for make-up comes from closer at hand and is made up from various springs and wells, from drainage, and from recovered water from the company's milling operations. Water from both sources is very turbid, high in bicarbonate hardness and sodium chloride, and requires softening and clarification before being admitted to the cooling-water system.

Additional polyphosphate stabilizing treatment is also employed for the control of scaling and as a corrosion inhibitor.

Make-up to the station service system originally was treated Utah Lake water the same as for the condenser cooling-water system. The corrosive qualities of this water when not sufficiently concentrated led to discontinuing its use.

The substitution of concentrated water (taken from the condenser cooling system) relieved the corrosion condition but brought about a clogging trouble.

The adoption of domestic or culinary water was the final

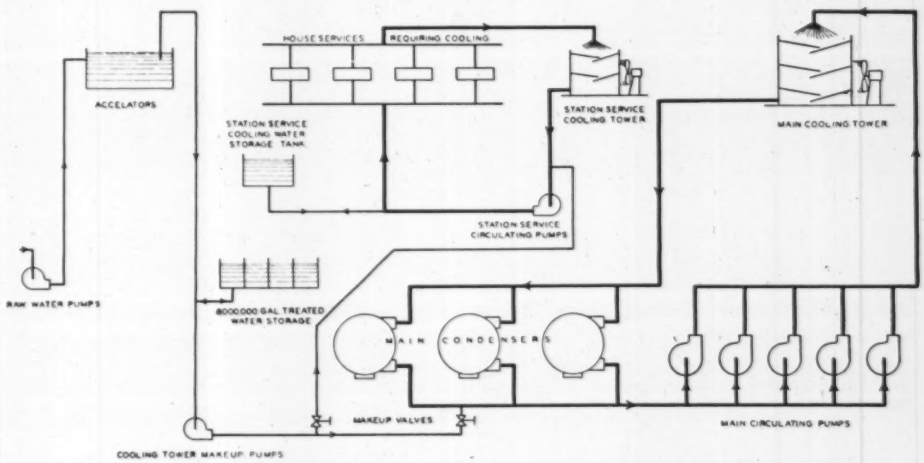


FIG. 9 FLOW DIAGRAM FOR COOLING WATER POR CONDENSERS AND STATION SERVICES

step. This water is chemically satisfactory for station-service cooling-water make-up providing it is not permitted to concentrate too highly in the towers, hence the proper amount of blowdown must be maintained. This water is also treated with a sodium polyphosphate compound for scale and corrosion inhibiting purposes and is chlorinated to eliminate sliming troubles.

The plant, consisting of two boilers and one 50,000-kw turbine-generator unit, has been in operation since April, 1944, except for the period from January 21 to June 29, 1946, when the mine and mills were closed by strikes.

The following operating results are the averages for the first six months of 1947 during which time all gas was burned during two days in January, 13 days in February, 20 days in March, and all of April, May, and June; all coal was burned 15 days in January; a combination of gas and coal was burned 14 days in January, 15 days in February, and 11 days in March: Boiler efficiencies, 87.94 per cent; turbine heat rate 9467 Btu per kwhr generated; plant heat rate, 11,771 Btu per kwhr delivered as useful power; plant auxiliaries, 6.94 per cent of power generated; over-all thermal efficiency, 28.99 per cent.

The plant has been unusually trouble-free with no unscheduled shutdowns because of mechanical failures. During the first few months of operation there were several power interruptions because of the shorting of insulators in the outdoor switch racks. This trouble has been overcome by painting the steel structures with aluminum paint and periodic cleaning of the insulators.

The usual minor troubles caused by leaks in flanged joints and valve bonnets caused by shutting down and starting up have been held to a minimum.

Reports From Germany

Prefabricated Housing

PREFABRICATED housing built in Germany during the war was almost entirely of the "self-help" type erected by the unskilled labor of the prospective occupant, according to a report (PB-60897) on sale by the Office of Technical Services, Department of Commerce, Washington 25, D. C.

Novel developments in lightweight concretes and prefabricated panels are described in another British report (PB-67458) on German building materials.

Four types of prefabrication were noted. Most frequently seen was the wood-panel type of construction. The panels usually consisted of frames covered with tongue-and-groove sheathing and lined with glass-wool or corrugated-cardboard insulation. The joints between the panels were covered by battens through which bolts held the building together. Occupants of these houses frequently complained of drafts and bad insulation.

Another type of prefabricated house was constructed of panels with wood wool cores coated with a magnesium-sawdust composition or with Portland cement. This system, too, was said to provide poor insulation.

Gypsum-sawdust panels were used in the type of self-help house considered most satisfactory. Building paper was nailed on either side of mortised wood frames. Over the paper, which formed a central insulating air space, were fastened reed mats as a base for the plaster-sawdust coat. Houses built with these panels were weatherproof and relatively attractive. The panels were strong and rigid, and the construction system was simple enough for amateur builders.

The fourth type of prefabrication used precast concrete slabs with precast lintel and post frames. The slabs were usually porous concrete covered with a dense concrete layer. These slabs were cemented in place and coated on the inside with plaster and on the outside with stucco. The system appeared to offer no advantages over regular concrete-block construction; in fact, the weight of the slabs probably made building more difficult, the report states.

Lightweight foamed concrete made by the hydrogen peroxide process was considered one of the most interesting developments in German building materials. The hydrogen-peroxide process was said to be simpler and easier to control than the aluminum-powder process for making foamed concrete. The bubbles formed by liberated gases were more uniform in size and the process could be used with any type of cement and under ordinary temperature conditions, it was reported. The cost of the hydrogen-peroxide process was slightly higher than the aluminum-powder process. Other German foamed concretes were made with "Iporit," an I. G. Farben product employing a sulphonic acid wetting agent, and the Asmus process which produced a foam with 10 per cent aluminum powder and 90 per cent calcium carbide.

Another outstanding building material found in Germany was the Schaefer slab, a precision-made composite concrete said to be quite different from any material used in the United States or Britain. The slabs were lightweight hollow-core pumice concrete covered with a dense concrete coat. Twisted pretensioned wires were embedded in the coating for reinforcement. The slabs were made in 30 and 50-in. widths and in varying thicknesses by an ingenious machine which produced lengths up to 180 meters. Pieces of the desired length were sawed from the completed slab. The Schaefer slab was used for floors, roofs, and walls. Buildings made from this material with simple mortared joints were found to provide good insulation and resistance to dampness.

Powder Metallurgy

Highly intricate dies employing a number of independent punches fitted in die subpresses were used by the Germans in pressing rifle and gun parts from powdered metals, according to a British report (PB-63874) on German powder metallurgy on sale by the Office of Technical Services. Iron powders were also used for porous iron bushings, bearings, sliding parts, gears, bullet slugs, precision parts for rifles, and diamond-impregnated iron-lapping wheels.

The entire assembly was designed for use in a standard type of hydraulic press with top and bottom rams which eliminated the need for complicated presses with multiple die movements, the report states.

Although electrolytic deposition, atomization, and reduction processes were used, the bulk of German iron-powder manufacture was the "Hematag" mechanical crushing process. In 1944 about 75 per cent of the total production was by the Hematag process.

The only improvement over American and British practices noted were in sintering furnaces. There were, however, unique improvements in specific plants which were not industry-wide.

At the Vereingte Deutsche Metallwerke, A.G., at Neurod, two types of sintering furnaces made by Elino of Kresbsoge, Rhineland, and Siebert of Hanau, were investigated. The Elino furnaces are straight-through tunnel furnaces, the work being packed into boxes and loaded into an end compartment and removed in a similar way at the other end or simply pushed into an open end and conveyed through without a charging compartment.

The Sieberg furnaces are of the tilting type with a central heating section 8 ft long with top and bottom heating elements of molybdenum. The cooling zone is 4 ft long and water-

jacketed. The loading arrangement consists of a cam working from an external wheel which engages with the back of the box and pushes it into the heating zone. The tilting of the furnace on the large rocker permits the boxes to slide down toward the discharge end by gravity.

The atmosphere in both types of furnaces is hydrogen or charcoal gas. The work is sintered in graphite boxes with a layer of aluminum oxide on the bottom and further layers between each layer of pressings to prevent welding of the compacts and absorption of graphite by iron.

Wool Preparation

German practices in preparing wool for carding and combing are described in report (PB-66124) on sale by the Office of Technical Services.

It is said that German equipment for opening, scouring, carbonizing, and drying wool are not up to American standards. Sorting practices, however, are very good and some unusual handling equipment is used.

One firm has an efficient combination crane and conveyer system to remove bales from ships along the quay and deposit them in front of an unusual conveyer which carries the bales to a sorting room some 1000 feet away.

The conveyer is supported by pairs of steel columns about 20 ft apart with an I beam connecting the tops. The pairs of columns are spaced approximately 100 ft apart. Steel bars about $1^1/_2$ in. in diameter are suspended underneath the I beams on open hangars to serve as tracks for carrier trolleys. The tracks are kept in tension by concrete weights to support the load, thus eliminating the need for closely spaced supports. The carriers are supported by a trolley consisting of two grooved pulleys which run on the steel bars when the carrier is gripped by a grab device and pulled along by a cable suspended alongside the track. The cable is driven by passing it around a large power-driven pulley lying in a horizontal plane. A mesh screen is suspended under the whole system to prevent injury if a bale should fall from the carrier.

Another firm has a unique method for blending wools using a portable Garnett type of machine. Two tracks are set in the floor of a long narrow room. The machine, set on a turntable, is mounted on a platform which moves along the tracks on flanged wheels to any desired location. The machine may be turned in any direction to discharge the wool into bins. One machine can serve at least 20 bins, the report states.

Toolmaking

German craftsmanship in toolmaking and care in using tools in synthetic-resin molding operations and processes is considered outstanding, according to a British report (PB-60394) on German molding plants on sale by the Office of Technical Services.

One of the most impressive machines noted was a copying miller for milling three-dimensional work from models by means of pantograph linkages.

The machine incorporated an optical device which enabled the operator to follow his work by keeping a spot of light focussed on the center of a screen. Reductions and enlargements were obtained by simple alterations of slide and pivot positions. It was reported that the range of tools made on this machine were of very high quality.

Particularly impressionable were two pairs of templates cut from gage steel $^1/_8$ in. thick. The male and female templates fitted together so exactly that when assembled and held to the light only a faint haze could be seen at some parts of the fit.

Another interesting machine, a 10,000-ton press used for making conveyer belts from Mipalm, had 5 × 2-meter platens and used a high-pressure water-cooling system. Production of the meter-wide conveyer belts required only 1500 to 2000 tons pressure. The maximum tonnage of the press had not been used.

Zinc Industry

A study of the German zinc industry is presented in a British technical report (PB-75873) on the uses of zinc in Germany on sale by the Office of Technical Services. The report gives information on equipment and methods used in rolling, extruding, alloying, die casting, and drawing of zinc. One chapter of the report covers the use of zinc as a coating and describes hot-dip, electrogalvanizing, and spraying methods.

Before 1939, the report states, German practices did not differ from similar methods in use in other countries. With the advent of the war, however, great emphasis was put on the use of zinc alloys as a substitute for brass, and to a lesser extent, for aluminum and lead.

The report includes a description of a novel vertical casting machine in which molten metal was injected by air pressure from a cast-iron bottle. The machine had a $17^1/_2$-lb casting capacity with a 24-in-square die platen and occupied an 8-ft × 6-ft area. It was said that the closing pressure was as low as 40 tons.

Zinc-alloy wire was used in Germany to a large extent as a substitute for copper or aluminum wire, the report states. The wire was produced almost entirely by rolling down cast bars to rod form and then by drawing. This process was reported to be cheaper than first extruding and then drawing. A method in use at one plant consisted of first casting circular disks which were rolled in about a $^8/_{10}$-cm thickness and one meter diameter. The rolled disks were then cut up spirally into rough $^8/_{10}$-cm-square rod which was later drawn down to wire.

It was found that more than 98 per cent of the total amount of zinc used for coatings was applied by hot-dip galvanizing which was carried out by a large number of comparatively small firms.

Infrared Gas Analyzer

Automatic infrared gas analyzers that can detect concentrations of carbon monoxide, carbon dioxide, or hydrocyanic acid as low as one part in one hundred thousand were invented in Germany just before the war, according to report (PB-48678) on sale by the Office of Technical Services.

The infrared gas analyzer was developed in 1938 by I. G. Farbenindustrie. Called the "Uras," the instrument can discover the presence of a simple chemical compound in a gaseous mixture and measure its concentration by irradiating the mixture with infrared light, of a wave length that only the compound can absorb. The resultant thermal expansion of the mixture is an identification of the compound; and the amount of expansion, a measure of its concentration.

I. G. Farbenindustrie manufactured about 400 Uras and used most of them for analyzing flue gas, determining the amount of methane in air, ethylene in ethane, and acetylene in ethane and ethylene, and for similar purposes. However, when the various gases in a mixture had infrared absorption bands that were close together, the instruments could not identify any one gas with certainty, the report indicates.

The appendix of the report contains technical data, in German, on the installation and operation of the Uras and copies of blueprints of its principal subassemblies.

Electron Tube Research

A RADIO tube smaller than the eraser of a lead pencil—only a trifle larger than a grain of rice—has been developed by the Tube Laboratory of the National Bureau of Standards. This tube, known as the "microtube," is but one development of a basic and applied research program on vacuum tubes, undertaken by the laboratory in collaboration with industry, for military and industrial uses.

An extensive study of electron emission from cathodes and other elements in the tube envelope is expected to lead to the eventual production of tubes more dependable, longer-lived, and perhaps cheaper than those now available. Other research deals with the prevention of "gas cleanup," the gradual absorption of gas in high-current relay and rectifier tubes used in industry. Finding and eliminating the causes of mechanical tube noise ("microphonics") constitute another important phase of the tube laboratory's work, as well as the development, improvement, comparison, and standardization of test methods and equipment for evaluating tube performance.

The most significant contribution made by the laboratory to the field of electronics is the development of new types of subminiature tubes in co-operation with private industry. In contrast to prewar tubes created by industry primarily for use as amplifiers in hearing aids, the new subminiature tubes are suited to a variety of other applications such as detectors, amplifiers, rectifiers, and oscillators. In the course of this work Bureau scientists found that a tube $^1/_4$ in. × 1 in. would perform specific functions just as well when simplified in certain ways. Simplification made further reduction in size possible; thus by a process of evolution the tiny microtube was developed. However, further details on this tube, which has various military applications, cannot be discussed at this time.

While the Bureau participated actively in all this work, one of its particular accomplishments is the reduction of microphonics and internal tube noise. Not only did subminiature tubes constitute a vital part of the famous proximity fuse, but they now promise, in conjunction with printed circuitry, to offer important aids to the entire electronics art. In fact, it is just such a tube, with a coil and other components printed on its envelope, that made possible the miniature radio transmitting and receiving sets constructed by Bureau scientists and exhibited at the recent I.R.E. National Convention.

Subminiature tubes, having proved themselves, are now considered a new tool of great potential value. Manufacturers are accordingly devoting much time and effort to seeking ways and means of exploiting the possibilities of such tubes in radio sets, improved hearing aids, and other applications.

Typical of other developments which will eventually have a profound effect in the industrial and commercial fields are the proposed long-life tubes that are being developed for use in electronic computing machines. Older models of such machines have utilized as many as 18,000 tubes, and some of the newer models, as well as others now contemplated, require as many as 2000 for a single machine. It is of paramount importance, therefore, to reduce tube failures to a minimum, thus not only maintaining continuity of service, but also greatly simplifying the problem of trouble-shooting and tube replacement. These new tubes are expected to have a life of 15,000 to 20,000 hr, or 10 to 20 times the expected life of present-day computer tubes.

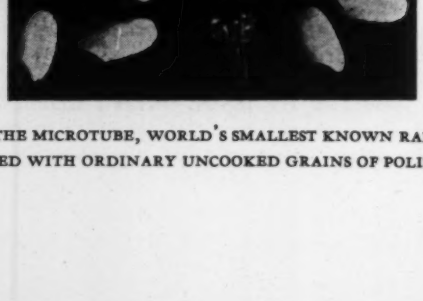


FIG. 10 THE MICROTUBE, WORLD'S SMALLEST KNOWN RADIO TUBE, IS COMPARED WITH ORDINARY UNCOOKED GRAINS OF POLISHED RICE

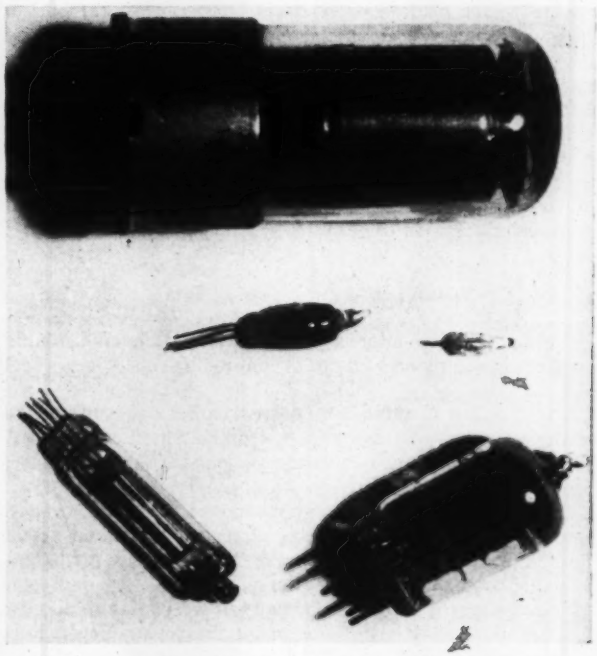


FIG. 11 THE MICROTUBE (*right, center*) ILLUSTRATES THE ULTIMATE OBTAINED IN THE TREND TOWARD MINIATURIZATION OF VACUUM TUBES

[This tube is compared with a bantam tube (*top*), a hearing aid subminiature tube (*bottom, left*), a miniature tube (*bottom, right*), and what was previously the smallest subminiature tube (*center, left*).]

Tin-Coating Steel

THE use of an extremely thin coating of tin (0.00005 in. thick) on mild steel before painting is found to provide an exceptionally good rust-resisting combination, according to an article in the July, 1947, issue of *Tin and Its Uses*, a review published by the Tin Research Institute, Middlesex, England. For purposes of comparison, a number of identical steel panels were painted directly, omitting the tin undercoat, and a further series was painted after different rust-prevention treatments. Tests with various steels and various paint compositions, including linseed-oil paint, nitrocellulose lacquer, stoving paints, and air-drying japans, have been carried out for more than four years and in every case those specimens which had been pretinned have retained their paint longest. An even more important finding is that the pretinned specimens have retained a clean tinned surface which is free from rust and can be repainted without preliminary scraping and cleaning operations whereas the surfaces of the untinned steels have rusted underneath the paint.

The use of pretinned steel would do much to improve the

appearance and prolong the life of automobile-body work and other painted steel products. The costs involved in applying an undercoating of tin of the recommended thickness (0.00003–0.00005 in.) to both surfaces of a sheet of steel are estimated at less than a quarter of the charges for labor and materials required to apply a single coat of paint to only one side of the sheet.

The idea of suggesting a thin tin coating as a protection to steel against rust is somewhat novel, as it is well known that ordinary tinplate rusts rather freely. The important fact is that a coating of paint over the tinned steel is said to entirely alter the corrosive conditions on the metal surface, and coatings such as zinc or cadmium, which have been found excellent when unpainted, make a very poor foundation for paint.

On the other hand tin has two outstanding qualities. It is inherently resistant to corrosion and its natural oxide film is so thin that tin will remain bright for long periods. In addition it has a peculiar affinity for oils, lacquers, etc. This latter, quality is a well-known feature of tin-base bearing alloys which retain their oil film with great tenacity and of tinplate which is frequently lacquered or lithographed as in packages and containers.

Rear-Engine Automobile

AN unorthodox, rear-engine automobile manufactured under the name of "Tatra" by a Czechoslovakian firm at Nesselsdorf, Sudetenland, is the subject of a report (PB-75857) on sale by the Office of Technical Services, Department of Commerce, Washington 25, D. C.

The power unit of the Tatra is placed behind the rear axle, and the cylinders of the V-8 air-cooled engine are arranged at an angle of 90 deg. The clutch is of the single-disk plate-type which has the advantage of requiring only low pedal pressure at normal engine speeds since the pressure-plate springs are assisted by a centrifugal weight system.

The chassis has a backbone frame which is rectangular in section with large lightening holes. Under the rear seat the frame splits into a fork which continues rearward. The fork is reinforced by a full-width vertical transverse member and a semicircular channel-section strengthening piece.

The sheet-metal underbody is supported at the front and rear by transverse full-width box-section members. The steel body gives added stiffness to the frame.

The steering gear is a rack-and-pinion type having direct push-pull rods to each axle. The column is insulated from this mechanism by a fabric rubber disk.

The hydraulic brakes use a fluid which appears to be 40 per cent water and 60 per cent glycol with some type of phosphate rust inhibitor.

The striking features of the body are its streamline shape and its exceptionally clean underbody. The rear engine location gives the advantage of maintaining an approximately constant ratio of front to rear wheel loading regardless of the number of passengers carried.

Location of the engine at the rear was extremely advantageous from the point of view of noise inside the car. In spite of a particularly noisy air-cooled engine in poor condition, the noise measurements inside the car showed up very favorably when it was traveling about 30 mph in high gear.

The forward driving position combined with the windscreen side glasses afford excellent forward vision.

The report concluded, however, that the benefits of some of the original ideas had been largely canceled by the adoption of construction features which made it impossible to take full advantage of the layout. Under all load conditions the Tatra was found to be inherently unstable at moderately high speeds. The use of an internally housed backbone frame, for example, made it impossible to obtain a low flat floor, which should be one of the great advantages of dispensing with the propeller shaft. The gear lever and hand brake are located on the top of the backbone frame making it impossible to move readily from one front seat to another.

Experimental Furnace

A REBUILT 122-ton open hearth furnace at the South Works of Carnegie-Illinois Steel Corporation, a subsidiary of United States Steel Corporation, located in South Chicago, Ill., features the use of basic refractories for all parts of its masonry construction exposed to high temperatures, with the exception of the walls and roofs of the checker chambers, the checker brick, floors and bulkheads of the slag pockets, and the roofs of the fantails.

Designed as an experimental furnace for use under commercial conditions to determine the economic and metallurgical advantages obtainable from a basic lining, it will also be used to study the application of oxygen as a combustion supplement. In addition, it will provide an opportunity for comparing the characteristics of various kinds of refractories. Experiments will include the use of oxygen in different kinds of burners, and the use of preheated compressed air for atomization of oil. Studies will be made of flame radiation, effects on furnace efficiency of the higher temperatures permissible with basic linings and of possible new steelmaking procedures.

All available data relating to the use of basic refractories in open-hearth furnace construction were carefully studied and correlated to evolve a furnace design appearing to offer the

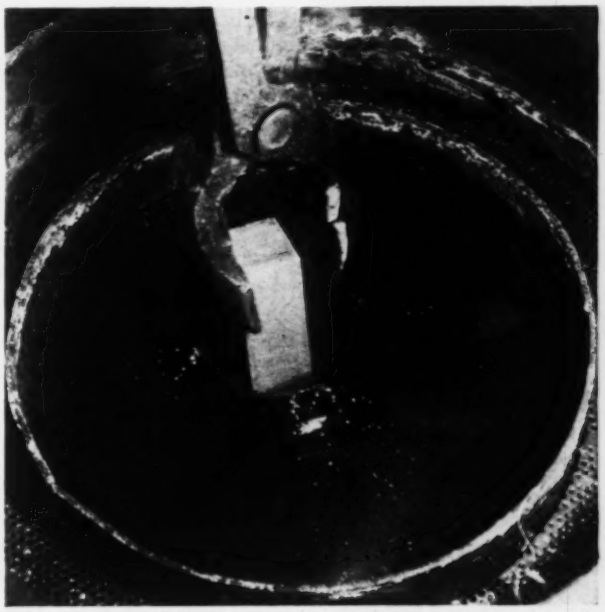


FIG. 12 A HOLE PUNCHED IN WATER IS SHOWN IN THIS PICTURE OF AN EXPERIMENTAL QUENCHING OPERATION AT THE RESEARCH LABORATORY, UNITED STATES STEEL CORPORATION OF DELAWARE, KEARNY, N. J.

(However, the "hole" which is really filled with invisible water vapor does not last long enough for the unaided eye to catch it. This photograph was taken with an exposure of $^1/_{10,000}$ sec, using a square bar of white-hot steel.)

simplest and safest solution to the various problems inherent in the use of basic brick. By using refractories of the same nominal types, but from different sources, it is intended to compare the characteristics of the several types as influenced by their compositions and methods of manufacture. This part of the investigation was furthered by using similar brick from different sources in comparable parts of the furnace.

Basic refractory brick and shapes used in building the masonry of the furnace were obtained from three independent sources and comprise five kinds. They include metal-encased and plain chrome-magnesite brick of the chemically bonded type; burned chrome-magnesite brick, some of which are encased in metal after burning and some intended for use with loose metal plates. In addition to the basic brick there are two grades of firebrick—a double-burned superduty brick, and a first-quality firebrick. Insulating brick is also employed along with insulating cement and concrete that serve the double purpose of insulating and sealing masonry surfaces.

Plastic Automobile

THE reinforced plastic automobile described by Louis A. Werner, engineering consultant, in the *S.A.E. Journal*, September, 1947, is unique in that it is structurally one piece, having no frame, rigid axles, brackets, or support. As a result, the body carries all the chassis load on built-in mounts at correct locations.

Reinforced plastic is used throughout the car, even to bumpers and wheel housings. Metal is used only for engine, drive shaft, wheels, axles, and linkage.

The car is the full width of the conventional type at the outside of the fenders, 190-in. over-all. The interior is 11 ft long and 6 ft wide, taking four persons comfortably in the rear seat, with two individual, movable chairs, besides the driver's adjustable chair. Other features include thermostat heating, air conditioning, full curved glass windshields with about one-half normal size "A" posts at the blind spots.

Interior lighting has been designed to eliminate reflected glare from both external and internal sources, whether sunshine or head lamps.

Wheels are independently sprung, without springs, suspension on each wheel being by means of air bellows with an expansion tank controlling frequency and softness of the ride.

The entire power plant and drive mechanism is at the rear of the car, and the trunk, spare tire, and luggage are at the front.

The body is a monocoque structure in its finished state, although about 10 major parts are mounted together to form this unit.

The plastic used is a thermosetting resin reinforced with glass fiber to give a tensile strength of 50,000 to 55,000 psi.

Six different resins are used on the entire car. Part of the structure is even made of balsawood core, wrapped with the fiberglas fabric, and then placed in an oven to be cured.

The main portion of the floor is a honeycomb structure 2 in. thick, thinning down to as low as $\frac{1}{2}$ in. in the auxiliary portions and the center structure.

Both rear and front bumpers are made in two pieces, curved to fit the contour of the fenders and body. They are U-shaped, $\frac{1}{4}$ in. thick on the outside structure, with honeycomb endwise to impact loading, then trussed across with an additional $\frac{1}{16}$-in. section at the middle of the U.

The windshield post and the door pillar post, being the only vertical structural members to take the entire load between the front and rear suspension, become the main supports of the car structure, thereby skin-stressing the top of the post to the body and to the side of the car. These become vertical structural members, making the car top both a tension and a compression member.

The front suspension is unique in that the suspension arms lie parallel to the center of the car, are inclined at the predetermined caster angle of the shock and suspension strut, and the center mounting is on a $1\frac{1}{2}$ in-honeycomb reinforced fiber construction with metal inserts between top and bottom plates. Each suspension link counteracts the other in its pull, thereby neutralizing the load at the center mount.

These suspension arms are rubber-mounted at the swing center and are in line with the steering gear tie-rod ball ends. The wheel, in its up-and-down travel, does not change its steering, toe in, tread, or caster. The rubber bushing eliminates transfer of shock load to the support.

The steering is laid out to steer on both front wheels with an over-all ratio of approximately 10.6:1. The standard automobile of today has close to 18:1. The fast steering makes it ideal for a quick maneuver on the road and fast recovery.

The car can be driven off the road at high speeds, over curbs, and through chuck-holes without any tendency to "kick" the driver, without discomfort to passengers, and with excellent recovery.

The engine and transmission are Mercury units, with the drive and arrangements as taken from Stout's original Scarab design, except that the drive from clutch to transmission has been revised to a multiple V-belt of $\frac{3}{8}$-in. section both ways.

The unit is cooled by taking air through a false window at the back and expelling it from the rear grille over the engine and then through the radiator. This method increases the normal running temperature 10–12 deg against a conventional method of cooling in a radiator only, as the air passing over the engine partially cools the block, manifolds, and other parts.

The exhaust system is simplified by not having any tail pipes; it has two short, flexible exhaust pipes and triple-pass mufflers. The engine, axle, and transmission are assembled as one unit, facilitating entire power plant removal by disconnecting the universal joints at the axle and removing four suspension bolts.

Synthetic Rubber

THREE improvements in synthetic rubber were described before a meeting of the American Chemical Society, September 17, 1947, by John C. Madigan, United States Rubber Company.

One of these improvements, announced for the first time at this meeting, is reported to be a new method of making synthetic rubber nonstaining.

The nonstaining feature is achieved by using a new rubber stabilizer or preservative which does not cause white rubber to darken on exposure to sunlight, and which does not stain white or light-colored surfaces with which it comes in contact. It is also nonodor-producing. Rubber made with this preservative can be used in lamp cords, refrigerator door gaskets, automobile window seals, white sidewall tires, and similar products.

About a 65 per cent reduction in the amount of water absorbed by GR-S synthetic rubber has also been achieved, principally by eliminating the use of salt in its manufacture. It was pointed out that low water absorption is very important when rubber is used in wire covering, since the less moisture in the covering the better its insulating properties.

The third improvement described is a method of improving the appearance and production efficiency of a number of synthetic-rubber products. Rubber is produced softer and easier

to handle in the factory by the use of about one half of one per cent of a special chemical known as a cross-linking agent.

Use of the softer type of rubber, mixed as desired with regular GR-S, helps speed up production of rubber-covered wire; improves the surface finish of boots, shoes, bathing caps, and the like; causes less tearing and smoother and better molding in forming tire sidewalls.

New Timepiece Hairspring

AFTER 15 years of continuous research, involving the combined metallurgical facilities of The International Nickel Company, Massachusetts Institute of Technology, and the Hamilton Watch Company, a new hairspring has been produced that answers an ancient problem of the watchmaker and endows all Hamilton watches with entirely new standards of accuracy, according to *Inco*, vol. 21, no. 3.

The secret of the hairspring is a new alloy based on an older alloy almost 30 years old, developed by the French scientist, C. E. Guillame, and known as Elinvar. New elements have been added and modern production practice has been introduced to give the alloy its almost magiclike properties. The new material has been christened "Elinvar Extra." Its composition falls within the range of 41–43 per cent nickel, 2.2–2.6 per cent titanium, 5.1–5.7 per cent chromium, 0.06 per cent (max) carbon, 0.3–0.6 per cent manganese, 0.3–0.6 per cent silicon, 0.4–0.8 per cent aluminum, 0.04 per cent (max) phosphorus, 0.04 per cent (max) sulphur, and the balance iron.

The name "hairspring" is a misnomer. Actually it is part of the beating heart of the watch that regulates the release of power stored in the mainspring and controls the five-times-per-second pulsing of the balance wheel, which, in turn, governs the train wheels that move the hands. It derived its name from an early English watchmaker, Dr. Robert Hooke, who conceived the idea of a balance spring in a watch, and for this purpose used a hog bristle in 1685. This was not an unqualified success and the bristle later was replaced with a steel spring.

The steel springs likewise caused trouble. They rusted, became magnetized, and their modulus of elasticity varied so much with changing temperatures that balance wheels were devised to compensate, as far as possible, for errors caused by variations in temperature.

Development of Elinvar aroused the interest of the makers of fine watches. Resistance to rust and nonmagnetic qualities were also features that the alloy required to give it high value in hairsprings. In 1931 it was adapted for Hamilton hairsprings.

It was felt, however, that something else was needed, and in co-operation with metallurgists of International Nickel and the laboratories of M.I.T., the studies went on. Modifications and changes in Elinvar were made, and the search for the ultimate material narrowed down to a smaller range.

It became evident that the elements in the modified alloy must be kept under the closest control, and that the alloy must be made under closely regulated conditions. To provide both these factors, a tiny induction furnace was built and installed in an air-conditioned room in the Hamilton plant at Lancaster, Pa. It has a capacity of producing up to 10-lb ingots. Special equipment for rolling and drawing down into wire was designed and built.

The composition of the ingot is controlled within extremely exacting limits. The air conditioning eliminates the danger of outside contamination, and melting and subsequent heat-treatment are so carefully controlled that there is little or no possibility of error, and all heats are uniform.

Each ingot costs approximately $5.00. After it has been forged and rolled into rod form it is machined so that all but two pounds of the original ingot is lost. This 2-lb rod is then rolled and drawn into wire so fine that it will provide a ribbon of wire 20 miles long, and hairsprings valued at $625,000 sufficient for 250,000 watches using the smallest-type hairspring. Some of the springs are so small that it would take the combined thickness of five of them to equal the diameter of an average human hair. They are mirror-finished to an accuracy of 1/200,000 in.

Hairsprings for watches were produced of Elinvar Extra on a limited basis in 1941. When the United States began rearming for the war, the normal source of supply for chronometers for the U. S. Navy—Switzerland—was shut off. Hamilton was commissioned to build them in this country. Its new hairspring plant, with its tiny furnace and rolling mills, was diverted from the smaller watch hairsprings to the larger chronometer springs.

It was found that the superior performance of these naval timing instruments was due in no small measure to the performance of the Elinvar Extra springs.

Since the end of the war, Hamilton engineers have used their war-gained knowledge to produce smaller and smaller hairsprings; first, for pocket watches, then for men's wrist watches, and finally for the very tiny wrist watches worn by women. In each case, however, it was found that slight variations must be made in the composition of the alloy. Experience indicated to what extent the variations should be made so that it was possible to produce springs that would measure up fully to the duties required in each case.

Turbine-Electric Steam Locomotive

THE three 6000-hp turbine-electric steam locomotives for the Chesapeake and Ohio Railroad, according to an article in the *Westinghouse Engineer*, September, 1947, by Charles Kerr, Jr., consulting transportation engineer, Westinghouse Electric Corporation, represent, in novel arrangement, a combination of elements all previously employed on locomotives. Each has the coal-fired steam boiler traditional to the reciprocating locomotive, a steam turbine, essentially similar to the one that has proved successful in the Pennsylvania Railroad S-2 geared-turbine unit, and the electric drive, common to the currently popular Diesel-electric locomotive. These new turbine-electric engines possess no fundamentally new elements untried in railroad service. The arrangement of these components, however, is unusual. At the front is the coal bunker, followed in succession by the operator's compartment, the boiler, and finally the turbine-generator power plant. Water is carried in a separate tender behind the locomotive.

The rightful place of the turbine-electric steam locomotive in the railroad scene will depend on its operating performance at different speeds and loads, efficiency, availability, maintenance requirements, first cost, and other factors important to railroad operators. Obviously some time must elapse before these can be set down with clarity. However, because this type of motive power represents a combination of basic proved locomotive elements, general appraisals can be made of the goals sought for it by the technical staffs of the Chesapeake and Ohio Railroad, Baldwin Locomotive Works, and Westinghouse, who conceived and executed it. Briefly, the turbine-electric locomotive assumes some of the performance colorations of all types. Since it is a steam locomotive it can burn coal, which makes it attractive to railroads traversing coal regions. Its starting and high-speed tractive-effort characteristics are said to be

superb, and correspond to those of the Diesel-electric locomotive. With regard to thermal efficiency, simplicity of operation, and freedom from reciprocating forces, it closely resembles the geared-turbine locomotive.

These locomotives will haul new ultramodern high-speed passenger trains between Washington and Cincinnati on fast schedules. The turbine-electric locomotive with coal as a fuel is an ideal combination to serve this region. Although the locomotives are intended for high-speed passenger service, the turbine-electric principle is extremely well-suited to all types of freight operation.

The propulsion equipment was designed to operate with a conventional fire-tube boiler and at pressures and temperatures commonly used with such boilers. The turbine receives steam at 290 lb pressure and 750 F total temperature. The turbine develops its rated 6000 hp when supplied with 85,000 lb of steam per hr, exhausting to atmosphere, and when operating at 6000 rpm. Geared to the main turbine are two double-armature, direct-current generators, operating at a maximum speed of 1000 rpm, which supply power to the eight axle-hung traction motors that furnish main propulsion power, two motors being permanently connected in parallel across each generator armature.

Speed of the locomotive is controlled by a variation of the generator excitation and the main turbine speed, the combination producing the maximum over-all efficiency and simplification.

Coaxial Cable

CONSTRUCTION has started on the first coaxial telephone cable to connect New York and Albany. The cable is jointly owned by the New York Telephone Company, the New Jersey Bell Telephone Company, and the Long Lines Department of the A.T. and T. Company, and is designed to supplement the communication facilities between New York, Albany, Buffalo, Cleveland, and Chicago.

About the size of a baseball bat, the new cable contains eight coaxial tubes, which are capable when fully equipped of handling about 1500 simultaneous telephone conversations. It will be 154 miles in length and will pass through the northeast corner of New Jersey and then near Southfields, Monroe, Kingston, and Catskill in New York.

The cost of the completed cable together with its initial line and terminal equipment is estimated to be about $4,000,000, which will be shared by the joint owners.

In addition to supplementing long-distance telephone facilities along this route, the new cable will also provide channels for carrying programs of the radiobroadcasting networks. If desired, some of the coaxials could be adapted for television transmission by the addition of proper equipment.

The cable will be placed in existing underground conduit between New York and Monroe, and between Catskill and Albany. Between Monroe and Catskill, most of the cable will be buried in the ground.

A new type of cable-laying plow will be used along the Monroe-Catskill section. First put in service earlier this year on the Washington-Baltimore route, the plow weighs some 27 tons. As it is towed along by tractors, it is able by means of a powerful hydraulic mechanism to adjust a plowshare to cut a slot in the ground as deep as five feet if required. A cable reel, towed behind on a trailer, feeds cable forward through the plowshare and into the ground.

Each of the eight coaxial tubes in the 154-mile cable is $^3/_8$ in. in diameter and is made of copper. Supported by insulating disks in the center of each tube is a copper wire about the size of the lead in a large pencil. The axes of the tube and wire are the same—hence the name coaxial. The coaxial is capable of transmitting an extremely wide band of frequencies. The cable will also contain a number of regular wire circuits some of which are needed for the complex control equipment required to maintain the cable.

The strength of electric currents carrying conversations through the coaxials diminishes rapidly and must be renewed by amplification approximately every eight miles. This amplification is provided by equipment in small "repeater" buildings, which are constructed at regular intervals along the cable's pathway.

The section of the cable which is buried in the ground will be given lightning protection in the form of two layers of plastic tape cemented over the sheath. These materials will be further covered by a casing of copper sheet placed over the plastic, forming a continuous tube over the cable. The entire length of the cable will contain dry nitrogen gas under pressure, and any reduction in this pressure, indicating a leak, will set off an electric signaling system at the nearest terminal point.

Climatic Hangar

ADDITIONAL information concerning the "Climatic Hangar," described briefly on page 777 of the September, 1947, issue of MECHANICAL ENGINEERING, is furnished in an article by F. A. Peckham, Engineering Division, Military Construction, Office, Chief of Engineers, War Department, Washington, D. C.

Mr. Peckham writes that the construction and preliminary testing of the huge experimental laboratory at Eglin Field, Fla., have now been completed, and the installation, known as the "Climatic Hangar" has been turned over to the Army Air Forces for operation. The project cost approximately $5,750,000 and required three years to complete. The hangar makes available to the A.A.F. adequate facilities for testing aircraft and related equipment under all possible climatic conditions which could be encountered.

The experimental hangar building provides a main test hangar approximately 250 ft wide × 200 ft deep with overhead clearance of 60 ft in the central portion, and an engine test room approximately 30 ft × 80 ft, as well as generous space for

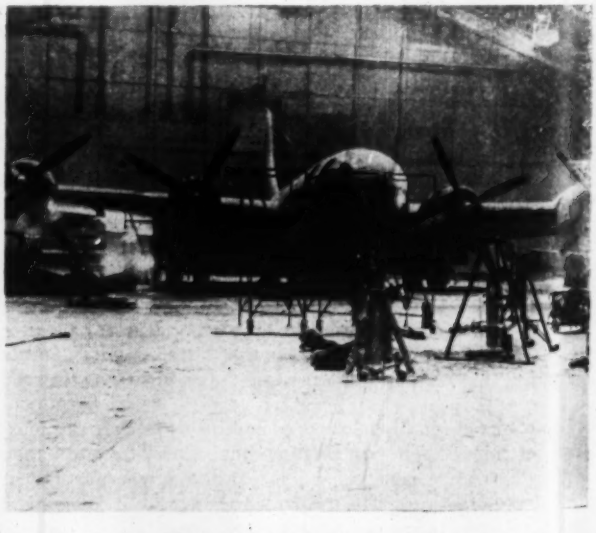


FIG. 13 A B-29 BEING TESTED IN THE CLIMATIC HANGAR

machinery rooms, instrument and control rooms, and offices. The walls and ceilings of the test rooms are insulated with approximately 13 in. of fiberglas and the floors are provided with 15 in. of load-bearing foamglass beneath the heavy concrete wearing floor. The hangar room will accommodate the largest bomber now in use, and the engine test room is adequate to permit block-testing of a 3000-hp aircraft engine. The two insulated hangar doors which enclose the 250-ft-wide opening are heavily braced with structural framework, properly counterbalanced with concrete blocks, and mounted on special railroad trucks installed on tracks along the front of the hangar. The hangar doors are electric-motor-driven through reduction gearing, and can be completely opened or closed in approximately ten minutes. The hangar doors are made practically airtight when in the closed position by means of inflated tubular gaskets installed around the periphery. Special ports are provided in the rear wall of the test hangar to permit the firing of machine guns or cannon under the conditions maintained within the hangar.

The test hangar is designed to produce and maintain any desired temperature between —70 F and +165 F, and any desired humidity between 10 per cent and 95 per cent consistent with a maximum vapor pressure of 1.5 in. of mercury. In order to accomplish and maintain these conditions the hangar is provided with an air-conditioning system consisting of eight fan plenums and necessary duct work, together with the necessary heating and cooling coils, humidification and dehumidification equipment, and controls. Two heating plenums and six cooling plenums are provided and the air handled is delivered to the hangar through vertical discharge outlets installed near the roof. An adjoining oil-fired boiler plant furnishes the necessary steam at approximately 100 psi for heating purposes, and a specially designed refrigeration plant supplies liquid freon to the cooling coils. Humidification can be provided either by sprays or steam jets, and the dehumidification is provided partly by ethylene glycol sprays and partly by refrigeration coils. The desired conditions can be maintained within ± 2 F.

The refrigeration system consists of three principal machines, each of which employs multistage centrifugal compressors for both high and low stages and requires 2250 hp of compressor motors. Two of these machines are capable of lowering the temperature of the test hangar from +95 F to —70 F, in approximately 30 hr, with summer conditions outside the hangar.

The test hangar is equipped with four separate systems of fire protection; fog, foam, Co_2, and sprinkler systems. The equipment is designed to quickly combat any type of fire and keep the resulting damage to a minimum.

Immediate experimental use of the hangar by the A.A.F. will be directed toward improved operation of aircraft and related equipment in subarctic temperatures.

New Jet Bomber

FIRST released photograph, Fig. 14, of the radical new experimental XB-47 jet bomber reveals its sleek lines and sharply swept-back wings and tail surfaces. Called the "Stratojet" by the Boeing Aircraft Company, which also manufactured the famed B-17 Flying Fortress and B-29 Superfortress during war years, the XB-47 is the world's first bomber to feature this new design philosophy. The ultrathin wings support six General Electric jet engines in double nacelles inboard and singly near the swept-back wing tips. Over-all dimensions of the Stratojet are similar to those of the B-29 Superfortress. Wing span is approximately 116 ft and length is 108 ft. The

FIG. 14 NEW EXPERIMENTAL XB-47 JET BOMBER

XB-47's unusual landing gear is of the tandem type. The main wheels retract into fore and aft sections of the body, while small outrigger wheels under each inboard power nacelle provide lateral stability during ground operations.

Fuel-Savings Bulletin

ANSWERING hundreds of practical questions on fuel-saving practices and fuel-conservation measures, the Bureau of Mines has combined in a single publication all of the material used successfully in the wartime National Fuel Efficiency Program that resulted in the saving of millions of tons of coal annually and in proportionate savings in other fuels, it was announced recently.

Launched during the war as a part of the nation's critical resources conservation campaign, the National Fuel Efficiency Program enlisted the aid of more than 20,000 volunteer workers in industrial plants, office buildings, apartment houses, schools, churches, hospitals, and theaters throughout the country to save fuel.

The effectiveness of the campaign has been demonstrated by the fact that many fuel-saving measures recommended during the war are being continued and extended to many other operations in peacetime. Although the program was concluded at the end of the war, requests for further information have continued at a high rate, according to Bureau officials.

The most effective material distributed during the 2-year campaign proved to be an extensive series of question-and-answer "quiz" sheets covering nearly every phase of fuel saving. All of these question-and-answer quiz sheets are included in the present Bureau publication, Bulletin 466.

In the preparation of the quiz sheets, many engineers outstanding in the field of fuel utilization contributed valuable suggestions based on years of practical experience with fuel problems. Experts in each field were chosen to prepare questions and answers, and the quiz series was divided into seven groups covering combustion equipment; draft and combustion air; instruments and controls; pumps, traps, and valves; cleaning and miscellaneous; heat utilization and distribution; and prevention of heat losses.

Bulletin 466 forms a companion to another publication now in preparation which will give a historical report of the National Fuel Efficiency Section of the Bureau of Mines personnel, methods of work, and accomplishments.

Copies of Bulletin 466, "A Guide for Reducing Fuel Consumption in Commercial Plants," may be obtained only from the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C., for 50 cents.

Two-Way Mobile Radiophone

A LITTLE over one year ago, The Willett Company of Chicago and Raytheon Manufacturing Company's subsidiary, Belmont Radio Corporation, announced completion of the first two-way mobile radiophone system for trucks. Now 49 units are installed and operating and they are said to be valuable aids.

The cost of a unit, plus operation, maintenance, depreciation and other miscellaneous charges are estimated to be approximately one dollar per day per vehicle. The current minimum rate per vehicle is four dollars per hour so that a 15-minute saving per day will pay for the set—a half-hour saving per day will give a 100 per cent return on the investment.

Typical of the everyday uses that are made of two-way radios was an accident observed by a driver involving a linen truck. The driver of this vehicle was seriously injured and rushed to a hospital. The driver who saw the accident radioed his dispatcher who promptly notified the linen-supply company, which was able to protect its valuable cargo and look after the welfare of the injured employee.

Radio has also facilitated maintenance operations. The drivers can call the shop and consult with the foreman on an unusual performance of their vehicles or mechanical difficulties, thus preventing breakdowns before they occur.

The two-way radio has given the dispatchers an up-to-the-minute picture of the constantly changing condition of the vehicles at their disposal. Trucks regularly assigned for a full-day's work on deliveries are now frequently radiophoned en route and given pickups on or near their routes. Time saved in avoiding parking and telephoning enables such pickups to be made the same working day—a not inconsequential saving when measured by hundreds of trucks.

The transmitter-receiver of the latest two-way mobile radiophone measures 6 in. × $6\frac{1}{2}$ in. × 15 in., and can easily be installed out of sight under the seat, in a trunk, or in a cab. The power supply is an integral part of the control unit which mounts under the dash in the front seat. It measures $4\frac{1}{2}$ in. × 6 in. × 6 in. The battery drain for the entire station is only 4.8 amp for the receiver and 18 amp while transmitting.

The antenna for the assigned frequency of 152 to 162 megacycles is about 18 in. long and mounts in the center of the truck or car roof, using the roof itself as the other half of the antenna system.

A complete unit may be installed in a truck largely through the use of several easy-plug-in connections with the truck batteries, the car roof antennas, and the grounding connections. This permits the radiophone to be lifted out in a matter of minutes should it become necessary to service it.

The transmitter-receiver unit is housed in a compact metal case which includes all the transmitting and receiving circuits except the power supply. The only external connection necessary for its operation are those to the power supply and antenna.

The transmitter-receiver is located in the main garage and connects with units in each of two dispatcher's offices. The antenna is mounted on the top of a nearby smokestack.

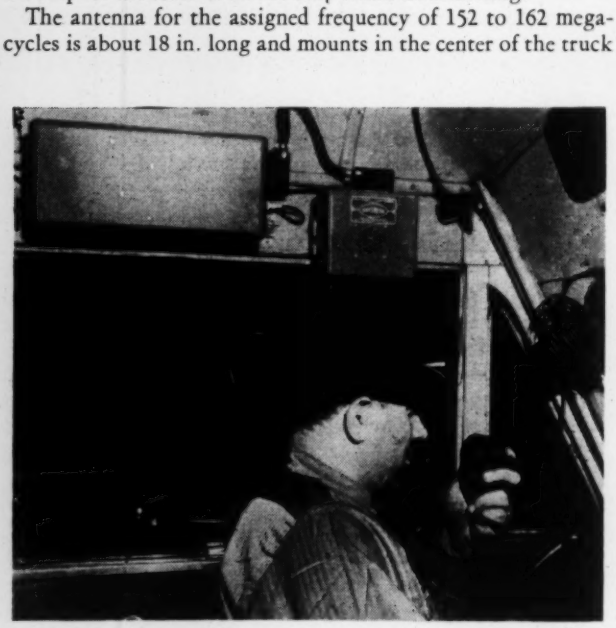


FIG. 15 TRUCK DRIVER AT MICROPHONE OF TWO-WAY RADIO. (Complete transmitting and receiving equipment is at upper left.)

Atomic Energy in France

AT the Fuel Economy Conference of the World Power Conference, The Hague, Holland, September 2–9, 1947, L. Kowarski, director of the Scientific Services of the Atomic Energy Commissariat, French National Committee, pointed out that in France, the future of atomic energy, more than that of any other form of energy, depends in part upon the progress which may be made mainly in the United States and Great Britain, and in part upon the international political situation.

He said that when we consider the number of relevant factors and especially the uncertainty concerning the uranium resources of the French Union, the speed with which French industry can be reconstructed, and the effectiveness with which international understanding can be developed, we see how fruitless it is to try to estimate in years the period within which we can hope to see atomic energy take an important place in the national economy of France. Under the most optimistic assumptions, it seems necessary to double the period of seven years which the Americans will have taken to produce their first source of useful atomic energy. It is thus only between 1960 and 1965 at the earliest that we can expect to have the first important and economically profitable plants functioning. Whatever the ultimate development may be, it is certain that now and in the immediate future, all plans concerning investments in the standard sources of energy must be continued as if the coming of atomic energy were still in the distant future.

The Atomic Energy Commissariat created at the end of 1945 and directed by Professor F. Joliot-Curie, is a state body endowed with financial autonomy and reporting to the President of the Council. Its immediate and essential duties include the assembling of corps of scholars and technicians familiar with the physics, chemistry, and technology of atomic energy, and as ready to put into practice techniques already developed as to make and develop original contributions.

Its plans call for the building of a group of laboratories and plants suitable to put into execution the foregoing task, and in particular to build apparatus releasing nuclear energy (piles) whose capacity is as great as primary material resources and knowledge will permit, and at the same time lend moral and material support to already established research establishments devoted to nuclear physical chemistry.

Another duty is to accumulate the primary materials necessary to achieve the utilization of atomic energy on an industrial scale and, for this purpose, to organize mineral prospecting and development in the territory of the French Union and to build the necessary refining and converting plants.

The Commissariat will also make a study of large-scale installations, collaborate with organizations working in allied

fields, maintain contact with foreign atomic scholars and technicians in so far as the international situation permits, and contribute to the widening of these contacts by advising the French Government in the negotiations on the international control of atomic energy.

The activity of the Commissariat, which began for all practical purposes in March, 1946, is exercised at the following places:

1 At provisional headquarters in Paris, for supervisory, administrative, and documentary purposes.

2 In existing laboratories (especially at the College de France, the Sorbonne, the Museum of Natural History, etc.) where certain apparatus is used directly or as models, and where certain members of the personnel are studying.

3 At Fort Chatillon, 6.2 miles from the center of Paris, where for the past several months important establishments have been building detecting and measuring instruments. The fort will also be used as a meeting-place and workshop by the groups of theorists and engineers making studies. Physics, chemistry, and mineralogy laboratories are being laid out and as they are completed they will gradually reduce the load on existing laboratories, already much too small for the rapidly expanding scientific personnel.

4 On land containing uranium deposits, especially in metropolitan France and in Madagascar.

5 On the Saclay plateau, 12.4 miles from Paris, where the Commissariat intends to establish a study center of applied nuclear physics. A large cyclotron, the first (several hundred kw) and probably the second (several thousand kw) atomic piles, and pilot plants for extracting the transmutation products will be built here. In this study center, no doubt, the first stages of the study of apparatus for using nuclear energy will be successfully completed on a pilot scale.

6 At Bouchet, 25 miles from Paris, where a plant for extracting pure uranium salts has been built by the Society of Rare Minerals following the specifications of and under the constant supervision of chemists of the Commissariat.

Since the work of the Commissariat has thus far been mainly organizational and educational, its liaison with industry is still very little developed except in the mining and chemical fields. So far as the physics and mechanical fields and their adaptation is concerned, what liaison has been developed has taken place through various study groups (Interdepartmental Committee on Gas Turbines; certain services of the Maritime Engineering Corps). As the atomic industry is gradually developed in France the Atomic Energy Commissariat will be able to play a more and more essential and far-reaching part in the various phases of the national economy.

Atomic Power Plant Model

BASIC elements of an atomic power plant are shown in the model, Fig. 16, constructed under the supervision of scientists in the General Electric Research Laboratory. Dr. Kenneth H. Kingdon, one of the first physicists to isolate uranium 235 from the natural element, is shown with model. Dr. Kingdon heads the atomic power division of the G. E. Laboratory.

The model is not full scale and is quite schematic. At the left is the atomic "pile" where matter is transformed into energy by the splitting of uranium or another fissionable element. In his left hand Dr. Kingdon holds a rod of this "fuel" material, while the stripped rods projecting horizontally represent the control rods which would prevent the process from running away. A heat-exchanging fluid would be pumped through the pile, thence to the heat-exchanger on the right, where water would be turned to steam. This would then be used to drive turbines in the customary way.

FIG. 16 MODEL OF ATOMIC POWER PLANT

The heat-exchanger step is needed because anything entering the pile would become dangerously radioactive, and thus steam could not be brought directly from it. The lethal radiations from the pile and the heat exchanger require that both be sealed in a capsule of concrete or similar protective material.

British Coal Survey

A PAPER, "The British Coal Survey: A Factor in Fuel Economy," by A. Parker and A. C. Maries of the Department of Scientific and Industrial Research, British National Committee, was presented at the Fuel Economy Conference of the World Power Conference, The Hague, Holland, September 2–9, 1947.

In the paper it was pointed out that the coal survey is a part of the fuel research organization of the British Government's Department of Scientific and Industrial Research. Its task is the systematic physical and chemical examination of the country's coals as they occur in situ below ground and as they are marketed at the pit head. Correlation of the analytical data with practical usage is obtained by observation and experiment on the behavior of the coals in industrial appliances, both at the Government's Fuel Research Station and at the works of private undertakings.

The survey of Great Britain's coals is not complete, but the main seams in production have been studied and a general picture has been obtained of the geographical distribution of different kinds and qualities of coal. Recently it has been possible to make a quantitative survey of the country's more readily available coal reserves, classified according to kind and quality, and this work is being extended to cover all the reserves.

The coal survey, combining an intimate knowledge of the properties of the coals with practical experience of their utilization, is well fitted to assist in promoting the more economic use of coal. It is also shown that the coal survey is of great value to the producer, the coal-preparation engineer, the distributor, and the consumer.

COMMENTS ON PAPERS

Including Letters From Readers on Miscellaneous Subjects

Industrial Waste Disposal

COMMENT BY F. W. MOHLMAN[1]

Extending the subject matter of this paper[2] to the Sanitary District of Chicago, we have surveyed wastes by actual sampling and gaging, since 1935, covering some 350 industries. Tests have covered 2 weeks' duration and in many cases several repeat surveys have been made. All outlet sewers are gaged by means of weirs, floats, Venturi or other types of measurement, samples collected every 15 min, and composite day-and-night samples analyzed. Daily losses in pounds are computed, in many cases after correction for the constituents in the influent water supply. In many cases, different departments or types of wastes are gaged and sampled separately. If possible, clean water which can be diverted from the outfall is measured and sampled, and efforts made to relieve the sewers of this unnecessary load.

The results compiled through 1944, the year of maximum production, are shown in Table 1 of this discussion.

Some plants have been surveyed since 1944, which are not included in this list, but their total will not change the results appreciably.

Over-All Effect of Industrial Wastes. The over-all effect of industrial wastes in the district, as indicated in Table 1, is 188 tons of solids per day and a population equivalent of 2,800,000. This compares with total human wastes of 400 tons of solids and a population of 4,000,000. The increase in organic solids, largely in solution, by industrial wastes, thus increases the human population load by 70 per cent, and the solids about 47 per cent. This applies to the entire district. The excess load on the Southwest Treatment Works is considerably greater. Most of the wastes listed are now discharged to the sewer system and thence to the sewage-treatment works.

COMMENT BY F. D. STEWART[3]

The authority of the Federal Government in matters relating to water pollution control is, in large measure, limited to scientific and technical investigations, to co-operation with the states in an advisory capacity, and to financial assistance to state and local authorities for investigations and construction. Some control is exercised over interstate waters, or more specifically navigable waters, wherein interstate commerce is affected, but in matters such as stream-pollution control of intrastate streams, the state authority is paramount.

In recent years Congress has been importuned to enact legislation whereby federal authority would be broadened, even to the point of including enforcement provisions to accomplish pollution abatement at the federal level. This has been opposed on the premise that such enforcement is a matter of state jurisdiction. It is agreed that aroused public opinion demands acceleration in accomplishments in the way of pollution abatement, but that this can be met best at the federal level by increasing the scope of federal activity along existing channels.

No one can gainsay that in pollutional matters the interests of the public health are of primary importance. Surely the protection of public water supplies and the elimination of nuisance conditions must be given first consideration. The maintenance of fish life and rendering streams fit for recreational usage are matters of importance too, but experience over the years has demonstrated that correction of stream pollution from the public-health standpoint automatically renders the stream fit for all other usages, including industrial use.

The United States Public Health Service has been a leader for many years in antipollution activities, and has made invaluable contributions to this program in the way of scientific investigations and research. These accomplishments, together with the paramount interest of public health in pollution abatement most naturally point to the Public Health Service as the federal agency in which antipollution work should center. This fact is recognized in pending legislation in Congress. It is most likely that any enforcement measures at the federal level will be limited to interstate waters.

State Control. There is a tremendous difference between the role of the state in pollution abatement as contrasted with the Federal Government. The state is vested with police power to compel guilty offenders to correct pollution.

[1] Director of Laboratories, The Sanitary District of Chicago, Chicago, Ill.

[2] "Industrial Waste Disposal," by George E. Barnes, MECHANICAL ENGINEERING, vol. 69, June, 1947, pp. 465–470.

[3] Assistant Chief Engineer, Ohio Department of Health, Columbus, Ohio.

TABLE 1 THE SANITARY DISTRICT OF CHICAGO INDUSTRIAL WASTE SURVEYS, 1935–1944

Type	Number of plants surveyed	Flow, millions of gal per day	Pounds per 24 hr: Suspended solids	5-day BOD[a]: Pounds	5-day BOD[a]: Population equivalent
ORGANIC					
Meat products	70	32.35	159626	164214	985280
Food products	38	8.99	21684	58494	350960
Milk products[b]	17	4.11	12566	24115	144690
Fermentation	36	7.05	28191	75878	455270
Tanneries	19	2.27	35410	18610	111660
Paperboard, textiles	8	7.16	26920	18805	112830
Laundries	17	7.74	14720	49000	294000
Soap and veg. oils	12	6.00	8383	17628	105770
Coke and tar	13	4.18	8515	18206	109240
Pharmaceuticals	9	1.01	1495	4335	26010
Railroads (roundhouses)	6	1.46	7300	1242	7450
Total	245	82.32	324810	450527	2703160
INORGANIC, CHEMICAL, OR TOXIC					
Iron and steel	15	5.93	10166	1012	6070
Nonferrous metals	17	8.67	15539	....	.....
Chemicals and paints	6	5.59	17534	9933	59600
Rubber, asbestos	4	1.96	1896	417	2500
Miscellaneous	16	6.67	6509	4899	29390
Total	58	28.82	51644	16261	97560
Grand total	303	111.14	376454	476788	2800720

[a] Biochemical-oxygen-demand measurement.
[b] Surveyed; total estimated.

and only differs from state to state in the degree to which each state avails itself of the opportunity to exercise that police power. Ohio practice is rather typical of the majority of states so a brief description of antipollution practice in Ohio is warranted.

Authority for pollution control is vested by legislative statutes in the State Department of Health and is twofold, namely, preventive and corrective. On the preventive side is the statutory requirement that prior to construction of public sewers and sewage disposal, plans therefor must be submitted to and be approved by the State Department of Health. Another statute imposes the same requirement with respect to the disposal of industrial waste. Thus the public interest is safeguarded, by the prevention of pollution. However, this measure is in no wise completely effective, so that additional authority is given the health department to compel offenders to correct existing pollution conditions. It has long been the practice to utilize this weapon only as a last resort, and in its stead to concentrate on education and persuasion.

Another "sign of the times" is the joining of states in a concerted effort toward stream-pollution abatement. Ohio is participating in the creation of "The Ohio River Valley Water Sanitation Compact," wherein all of the states in the Ohio River Basin, by legislative authority of the several states, set up an authority to deal with and correct the existing pollution of the Ohio River.

Proper disposal of industrial wastes has been and still is a problem of major importance. Professor Barnes has given the technical data to show the pollution effects of indiscriminate discharge of untreated wastes into our streams and lakes. Some accomplishments have been made, but accusations of carelessness and a disregard of responsibility on the part of industry are difficult to refute, when actual accomplishment is considered. So often the excuse for guilt and the failure to take definite steps to solve the problem is attributed to the statement "no practical treatment is known." In many instances this is true, but nothing is done about it. The very least an industry can do is to segregate pollutional wastes from "clean" waters, such as cooling water, so that the detrimental wastes can be easily and cheaply picked up for treatment. Furthermore, industry as a whole has not seen fit to consider the problem of waste treatment as a matter for intensive research and study on its part, in spite of the real accomplishments that have been made in research along other lines of endeavor.

The most promising development along these lines has been the undertaking of real study of waste disposal on an industry-wide basis, by several types of industry, such as the work of the "National Council for Stream Improvement" of the pulp, paper, and paperboard industries.

In all fairness to state agencies vested with pollution abatement, statistics show real accomplishment over the years. For example, during the period from 1920 to 1940, the number of municipal sewage-treatment plants in Ohio increased from 63 to 182, representing populations served of 887,900 in 1920 and 3,230,400 in 1940. Definite progress was also made in improving industrial waste disposal in this same period in upward of 200 instances, either by installation of treatment devices; by improvement in plant procedure with re-use of water, or the so-called "closed system" of liquid waste; or by the development of useful by-products which would eliminate some of the wastes. However, aroused public opinion is now demanding acceleration in stream cleanup, and much remains to be done, as witness the estimates of work required in both municipal sewage treatment and industrial waste disposal, in terms of costs, as set forth in this paper.

Mention should be made of a trend in pollution control at the state level, whereby this control is delegated to a board or commission, including representatives of all parties interested in pollution abatement, instead of just public-health authorities. There is no disposition for the most part to lessen the role of public health, as most states having such boards incorporate the personnel of health agencies who have been actively engaged in pollution control, and who are trained and experienced in this complex work. The movement merely broadens the scope of authority, bringing into the picture in addition to public health, municipal, industrial, fishing, and recreational interests. This appears to be a healthy sign and should be productive of better accomplishment in pollution abatement.

Local Responsibility. It is at the local level that actual financing and construction of improvements to prevent and correct stream pollution are accomplished. In many instances, industry must act cooperatively with municipalities. In addition to installing necessary improvements, both industry and municipalities must properly maintain and operate devices and equipment after construction. This involves the expenditure of money, and consequently financing is as important as the technical aspects of the problem.

Although compulsion when necessary to correct bad conditions originates at the state level, municipalities do have a certain amount of responsibility, particularly in the case of industries within corporate limits of towns and cities, to accomplish cleanliness in watercourses or other bodies of water.

COMMENT BY F. C. TOLLES[4]

A solution to the problems of industrial waste disposal should represent fusion of the objectives and techniques of engineers concerned with processing and those who have the viewpoints of sanitation. The author makes succinct statement of the latter. Because of limitations, he has not dwelt upon more unusual considerations of the sanitarian such as those involving the possible chemical interaction of wastes from different industries; or the special situation of ground-water pollution; or the question of accidental "spills," their probability and effect. The author counsels caution in any expectation of the recovery of net values from industrial wastes; this is sound but should be coupled with recognition that waters recovered from wastes may have use in industry itself as at Baltimore or otherwise as in irrigation for arid areas.

Again from the standpoint of the sanitary engineer who approaches problems of treating and disposing of wastes, there should be appreciation of the necessity of flow sheets which are quantitative as well as directional; and also of analyses of segregated and composite wastes which, from planned sampling, show variations in quantity and in characteristics. Analytical results, moreover, should be proved, wherever possible, by the differentials between input as raw materials and output as finished products.

As the author implies, wastes disposal can, sometimes, be reduced in bulk—and resulting expense—by a structural revision of drainage lines to enable the ready segregation of waters relatively uncontaminated; cooling waters for example. In turn, this suggests the advantage of plant planning which keeps this possibility in mind. Sewers really may be important.

The writer also bespeaks the need for attention to the operation of works for the treatment of industrial wastes. In reality, such operation is but the extension of plant processing, and industry which controls its products by supervision, inspection, and test is in position to appreciate that proper results and return upon investment call for reasonable

[4] Havens & Emerson, Consulting Engineers, New York, N. Y., and Cleveland, Ohio.

supervision and check of the processes of treatment and disposal.

It is worthy of note that the author has based his presentation upon proper utilization of the powers of natural purification which are inherent in surface waters. Such represents the attitude of the sanitary engineer subject, of course, to modification which recognizes the after use of those waters. The point is mentioned to distinguish this approach from that of the demand, sometimes heard, that our streams be restored to primeval purity. There are cases of the more remote recreational waters where it is proper to strive for this ideal; the extension of co-operative attitudes by industry in abating pollution will keep any demands for unreasonable purity within due bounds.

COMMENT BY A. G. WALL[5]

The writer's company, which, for many years, has manufactured sewage-disposal and garbage-disposal grinders, would like to know along what lines the municipalities are planning to dispose of industrial waste and garbage. The author mentions that approval of the local city sanitary district is required before discharging industrial waste or garbage into the sewage systems; but up to the present time the larger cities refuse to give such approval.

Most cities are interested in rodent control and have attempted to carry out programs for such control. We know that the breeding ground of rodents and other disease carriers is garbage. Every restaurant and hotel would be greatly interested in grinding garbage for disposal rather than placing it in cans to be picked up some hours later. However, they cannot secure permission for the installation of such equipment, as they are not allowed to discharge the ground garbage into the cities' sewers.

We understand, of course, that sewers are planned some fifty years in advance; and the answer to the question at the present time is that the sewers are not adequate. However, what we want to know is whether or not the cities are taking this into consideration in future plans. In one instance, a company customer desired to grind fish heads and discharge this waste into the sewers in the city of St. Louis, but was not allowed to do so.

Certain cities in the western part of the United States are considering garbage disposal in their sewage systems to take effect shortly. In fact, we know of one city in a western state which has been considering the passage of an ordinance requiring every public eating place in the city to have a garbage-disposal unit. There are also instances where garbage grinders even now are being sold to hotels and restaurants in the southwestern part of this country for disposal into sewage systems.

It is our policy to present these facts to the sanitation districts of our large cities when they are planning future sewage systems so they will take into consideration the possibility of this added sewage in the systems. By this method, the present makeshift systems employed by our various large cities for rodent control can be eliminated; and as brought out by the American Medical Association, disease can be curbed by the sanitary handling of garbage.

AUTHOR'S CLOSURE

The discussions by Messrs. Mohlman, Stewart, and Tolles amplify the material in the original paper. Here are given the well-considered viewpoints of sanitary district authority, representative of state and interstate directing authority, and consulting sanitary engineer. These contributors raise no questions, and their remarks extend the scope of the paper and make it just that much more useful to the group for which it was intended; that is, the engineering and management group of industry which is presently brought up short under pressure for suitable waste-disposal measures.

Mr. Wall raises a question on the disposal of garbage which is a matter of much concern in many municipalities. Unfortunately, no general and categorical answer can be given. It is generally accepted that the organic nature of garbage makes it amenable to treatment along with the other organic matter in sewage and by the same methods; but the matter of bulk alone makes it prohibitive in many cities to accept garbage via the sewers. In many cities, the treatment works are designed only for the ordinary solids loading of domestic sewage and cannot handle excess loads. If garbage, as one of the ordinary by-products of community living, is to be disposed of by water carriage in the future, plant designs must take this into account. And until there is a meeting of minds on this topic between the city officials who make the policies for municipal housecleaning methods, and the engineers who design the cities' plants and utilities, the city resident will have to dispose of his garbage by means already provided. More modern, convenient, and economical means are already being widely adopted.

GEORGE E. BARNES.[6]

[5] Chief Engineer, Gruendler Crusher and Pulverizer Company, St. Louis, Mo.

[6] Professor of Hydraulic and Sanitary Engineering; Head, Department of Civil Engineering and Engineering Mechanics, Case Institute of Technology, Cleveland, Ohio. Mem. A.S.M.E.

Stress in Welded-In Heads

COMMENT BY T. C. RATHBONE[7]

Actual tests on various constructions for the experimental verification of calculated stresses and strains, such as described in this paper,[8] are always welcome. The setup for running a fatigue test was particularly interesting, and should be found useful for similar future investigations.

However, it is not always safe to draw broad conclusions from an isolated test on a model made under ideal conditions, and especially where there may be a possibility of "scale effect" preventing general application, and extraneous stresses.

The particular case which evidently "sparked" the investigation was a vessel made of 8-in. pipe with $^1/_2$-in. flat heads, wanted for 200 psi. U-39(*a*) called for a head 0.76 in. thick, or about $^1/_4$ in., or 7 lb, or about 25 cents more per vessel, than used. Unless produced in considerable quantity the extra cost of metal, as compared with the fabricating cost (same for both thicknesses), would seem to be insignificant.

On the model vessel described in the paper, $19^1/_4$ in. diam, $^3/_8$-in. shell, 0.775-in. head, the flat-head support lies somewhere between the "free-edge" and the "fixed-edge" condition. Standard formulas for stress in the head for the two limiting conditions (P = uniform pressure, m = reciprocal of Poisson's ratio = 3.45 for steel) are as follows.

Free edge at center

$$St = Sr = \frac{3Pd^2(3m+1)}{32mt^2} = \frac{0.305Pd^2}{t^2}$$

Fixed edge at center

$$St = Sr = \frac{3Pd^2(m+1)}{32mt^2} = \frac{0.121Pd^2}{t^2}$$

Fixed edge at edge

$$Sr = \frac{3Pd^2}{16t^2} = \frac{0.1875Pd^2}{t^2}$$

[7] Chief Engineer, Machinery Division, The Fidelity and Casualty Company of New York, New York, N. Y. Mem. A.S.M.E.

[8] "Stress Investigations of Flat Welded-In Heads," by H. M. Spring, Jr., MECHANICAL ENGINEERING, vol. 69, June, 1947, pp. 482–484.

From Code, U-39(*a*) Fig. f, U-4

$$S \text{ (allowable)} = \frac{0.50Pd^2}{t^2}$$

The constant C, of 0.50 in the code formula for this particular design does not attempt to take into account any reduction for the edge fixity furnished by the attachment to the shell, which is uncertain and variable, depending upon the relative thickness and rigidity of the shell itself. The constant specified is properly greater than the theoretical 0.305, to allow for uncertainties of metal damage due to welding, and the additional stresses set up in shell and weldment due to local flexure, shear, etc. The increase in the shell stress due to the restraining head may be over 80 per cent. It will be noted that a C for the theoretical 0.30 is allowed for constructions U-4 (*k*), (*l*), and (*m*) where a factor of safety of 5 is assured in the head with no complications.

For the actual model dimensions, the theoretical stresses at the center lie between $S = 189\ P$ for free edge, and $S = 75\ P$ for the fixed edge. The actual stress observed (scaling the chart, Fig. 4 in the paper) is $S = 125\ P$, almost midway between the fixed- and free-edge value, indicating nearly 50 per cent contribution from edge fixity. Also, the radial stress at the edge, observed on gage No. 5, indicates about 6500 psi per 100 psi P, or $S = 65\ P$, which is over one half the value that a fully fixed-edge support would call for ($S = 116\ P$). The stress would be zero at a free edge.

Thus, judging from these stress values, a definite contribution from edge fixity in this particular model is included in the test results which the author uses in concluding that a constant of only 0.192 might be appropriate.

The observed deflections at the center, however, indicate only a slight degree of edge fixity. The theoretical deflections at the center for the two cases, again based upon standard formulas, and assuming $E = 29.5 \times 10^6$ and $m = 3.45$ are

For free edge =

$$\frac{3Pr^4(m-1)(5m+1)}{16Et^3m^2} = \frac{2.40 \times 10^{-8}Pr^4}{t^3}$$

For fixed edge =

$$\frac{3Pr^4(m^2-1)}{16Et^3m^2} = \frac{0.58 \times 10^{-8}Pr^4}{t^3}$$

For the model dimensions, 19¼ in. diam and 0.775 t

Free edge, 44.0 mils per 100 psi P
Fixed edge, 10.7 mils per 100 psi P
Observed, 42.0 mils per 100 psi P (scaled from chart 4)

Of course, E may range from 28.5 to 30.5 million, and m from 3.3 to 3.7, varying the free-edge-case deflection from 42 to 46.5 mils per 100 psi P. However, it is surprising that the test values come so close to the theoretical free-edge-type deflections, while the observed stresses indicate a very considerable fixed-edge effect, or, to put it the other way, that the stresses were not greater and in keeping with the deflections observed. The two do not appear to be compatible.

The fatigue test for this particular construction is more of a test on the weldment and shell than on the head itself. As the head dishes under pressure, the edge attempts to rotate and draw in, imposing great forces on the resisting shell. The free-edge tangent angle for 93 psi P would be over ⅓ deg. Also, as noted, the restraint on the shell diameter may increase the stress locally over 80 per cent. Considering these strains at the weldment locality, it is remarkable that the test ran to nearly 9,000,000 cycles before failure, but it is natural that the failure occurred where it did.

Although the code requirements may appear quite conservative for very small objects, the suggested constant $C = 0.192$, based upon one model test, taking advantage of some degree of fixity, and in which observed stresses and resulting strains do not appear to be compatible, would not be valid for broad application, particularly on larger vessels. Moreover, the theoretical value, 0.305 for the free edge, should properly be increased to accommodate the uncertainties of local stresses and metal damage at the weldment, on top of the factor of safety of 5 on nominal stress. After all, the prime reason for a code is safety.

AUTHOR'S CLOSURE

Mr. Rathbone's comments should be of particular interest to those interested in strength of structures and in the approach toward analysis of design. Several points brought up develop comment in reply to explain better the details and intent of the tests.

The test tank was fabricated in production with other "Code" vessels of the same material, same setup and by the same workmen. This is mentioned to show that the quality of workmanship should be typical of that found in the average pressure vessel.

In regard to the thought that cost was the primary consideration in thickness of flat heads, it should be pointed out that there are many pressure vessels in service so constructed. The owners of such vessels naturally wish to avoid the need of unnecessary replacement of such vessels if it can be shown that they are suitable and safe for the desired pressures. Actually, the fabricating cost will not be the same for different thicknesses since, as the thickness increases, additional passes of welding are required. The time for welding is one of the important factors in cost of fabrication.

The so-called "standard formulas" appear to have been developed a number of years ago and before any up-to-date instruments for precise strain measurements were available. The writer feels that full advantage should be taken of up-to-date methods of strain measurements so that progress will not be impeded by standardized practices that have been out dated. It is realized that the constant of 0.50 for C in the Code does not attempt to take into account any reduction for the edge fixity. The fact remains, however, that with the edge beveled and welded for full thickness with an additional full fillet weld as specified by A.S.M.E. Fig. U-4(*f*), there is a very definite fixity. The specifications are very definite and it does seem as though some allowance might be made.

No attempt was made to predict the performance of the vessel in advance of the test, and it was rather gratifying to learn that the performance was not in complete or dependable agreement with the standard formulas which were questioned. While Mr. Rathbone claims that the fatigue test was more of a test on the weldment and shell than on the head itself, it does seem important to note that the head did not fail under a hydrostatic pressure of 1340 psi although the standard formula would limit the pressure to 36 psi. It will be recalled that the test of 1340 psi was applied after the nearly nine million cycles of pressure during the fatigue test.

Mr. Rathbone is quite correct in pointing out that with the edge dishing under pressure, the edge attempts to rotate and draw in. This was not mentioned in the report but it was observed during the test.

In conclusion, it is felt that the path has been opened for further consideration of the flat-head formula, and it is hoped that further tests will be conducted to produce added data on the subject.

H. M. SPRING.[9]

[9] Assistant Chief Inspector, Mutual Boiler Insurance Company of Boston, Boston, Mass. Mem. A.S.M.E.

On the Velocity Distribution of Turbulent Flow in Pipes and Channels of Constant Cross Section[10]

COMMENT BY R. B. MONTGOMERY[11]

It is found in this paper that the velocity distribution for turbulent flow in circular pipes is well represented by the paper's Equation [25], which contains two constants, $a = 1.53$ and $\kappa = 0.40$, the latter being "von Kármán's universal constant."

Professor Wang was apparently unaware of a previous investigation[12] which, like his, sought for a better representation of velocity distribution than the existing formulas of Prandtl and von Kármán. In the previous investigation, the plausible hypothesis was made that the distribution of mixing length in a cylinder of any shape is represented by

$$l = \kappa\left[2\left(\int_0^{2\pi}\frac{d\theta}{s}\right)^{-1} + z_0\right]$$

where, in a plane normal to the axis of the cylinder, s is the distance from the point where the mixing length is l to the wall in the direction θ. The nondimensional quantity κ is the turbulence constant. The length z_0 is of importance near the boundary only and is negligible for present purposes. For circular cylinders, this hypothesis yields, for mixing length

$$\frac{l}{r} = \kappa(1-\eta^2)\times \left(2\int_0^{\pi/2}(1-\eta^2\sin^2\theta)^{1/2}\,d\theta\right)^{-1}$$

and, for velocity

$$\frac{u_{max}-u}{v_*} = \frac{2}{\kappa}\int_0^{\eta}\int_0^{\pi/2}\frac{\eta^{1/2}(1-\eta^2\sin^2\theta)^{1/2}}{1-\eta^2}\,d\theta\,d\eta$$

where r is the radius of the cylinder, η is the relative distance from axis, u is the mean speed at relative distance η, u_{max} is the mean speed at the axis, and v_* is the friction velocity at the wall. The last two equations agree well with Nikuradse's measurements if the turbulence constant has the value 0.45. Owing to the high accuracy of the measurements and to the plausibility of the hypothesis, there is reason to consider 0.45 to be the most reliable value for the turbulence constant.

Since Professor Wang's paper is more empirical and depends upon the introduction of the additional constant a, while the agreement with measurements is good in both papers, its only advantage appears to lie in the more tractable mathematical form of the resulting equation. Otherwise, the treatment offered in the previous paper appears to be preferable.

It may be pointed out that the disparity between von Kármán's formula and Nikuradse's measurements is much less if the turbulence constant, instead of being assigned the value 0.40, is assigned the value 0.31, which, without being explicitly stated, was used by von Kármán[13] in fitting his formula to the measurements.

[10] By Chi-Teh Wang, published in the June, 1946, issue of the *Journal of Applied Mechanics*, Trans. A.S.M.E., vol. 68, p. A-85.

[11] Physical Oceanographer, Woods Hole Oceanographic Institution, Woods Hole, Mass.

[12] "Generalization for Cylinders of Prandtl's Linear Assumption for Mixing Length," by R. B. Montgomery, Annals of the New York Academy of Sciences, vol. 44, art. 1, "Boundary-Layer Problems in the Atmosphere and Ocean," May 29, 1943, pp. 89–103.

[13] "Turbulence and Skin Friction," by Th. von Kármán, *Journal of the Aeronautical Sciences*, vol. 1, Jan., 1934, pp. 1–20 (see Fig. 8).

Coal-Handling Methods

COMMENT BY N. E. COALWELL[14]

The subject[15] of storing bituminous coal is of considerable interest to the writer and the methods described in the paper have much in common with our experience.

In 1937 we were faced with the problem of storing coal in greater quantities than heretofore had been stored without loss due to heating and fires. After investigating all of the best-known handling methods and giving consideration to the initial cost, as well as to operating costs, we decided to use earth-moving equipment, namely, crawler tractors and carryalls. With this equipment two objectives are accomplished; (1) moving the coal from the dock face to the storage area, (2) compacting the storage coal, thus eliminating the fire hazard.

We have been handling approximately 600,000 tons of coal annually; of course not all this is stored. Part of the tonnage, constituting our current requirement, is loaded directly from the boat into coal cars through a track hopper. We use three tractor carryall units of 12 to 15-cu yd capacity. These units transfer, store, and compact 150 to 180 tons per hr on a 250-ft one-way haul. We use a crawler crane with a 4-cu yd clamshell bucket for reclaiming the coal from the storage area during the winter months.

Incidentally, we are treating all our coal with calcium-chloride liquor. The coal loaded at the docks in Toledo, Ohio, is treated at that point. Our coal loaded elsewhere is treated by ourselves as unloaded. This treatment has been very satisfactory in preventing dusting and wind loss, as well as freeze-proofing the coal during winter reclaiming and transportation to our powerhouse which is located in Midland, 20 miles from our receiving dock.

COMMENT BY E. W. DILL[16]

The authors are to be congratulated for the extremely practical and workable system for handling large shipments of coal which they, as co-designers, have made available to us to operate. It has proved to be singularly free from operating difficulties, easy to maintain, entirely adequate in all aspects, and cheap to operate.

Preparation of the paper was undertaken early in 1945. Since that time a few minor changes in operating technique have taken place. It has been found beneficial to detach the crankcase guards and track guards. It was discovered that when working in loose coal, such as the stock pile under the revolving boom, these guards only put additional drag on the equipment. Spraying the coal at the loading dock with "Wetsol" has been discontinued because of the skin irritation it induced on the tractor men's arms, faces, and necks, particularly during warm weather when perspiring freely. Instead, a water spray has been installed at the top of the revolving-boom conveyer which directs a stream of water on the coal as it spills over the discharge pulley. A supplementary spray nozzle can be applied to wet the coal as it feeds from the dock hopper onto the first shore conveyer. This wetting has proved adequate to allay undue dusting.

It will no doubt be implicit as one reads through the listing of the number of men required for the different coal-handling operations that the three conveyer men, one tractor-bulldozer opera-

[14] General Plant Superintendent, The Dow Chemical Company, Midland, Mich.

[15] "Coal Handling With Earth-Moving Equipment," by R. L. Hearn and R. F. Legget, MECHANICAL ENGINEERING, vol. 69, July, 1947, pp. 559–563.

[16] Polymer Corporation Limited, Sarnia, Ont., Can.

tor, and the dock foreman common to all operations constitute the basic operating crew. The conveyer men's regular daily function is to route coal through the crushers and up the conveyer system into the boiler coal bunkers; and on such days as coal shipments are being received they take over the extra duties of running the dock-conveyer system, supplemented with help from the coal-bunker men stationed over the coal bunkers to keep coal moving freely through them, and from the labor gang if still additional help is needed. Only such time spent by this crew on coal-unloading operations is charged to coal unloading. Their regular duties of transporting coal from the grizzly reclaiming hopper through the crushers and into the bunkers is, of course, a charge against the cost of steam.

Table 2 of the paper, "Unit Operating Costs," for the years 1943, 1944, and 1945, have been erroneously charged with operating wages for the coal-handling crew for time spent on coal reclaiming. This is an accounting error which was only discovered when extending these cost data beyond September 30, 1945, to bring them up to date. Other small refinements in cost allocation have likewise been made, and an amended table of unit operating costs is shown herewith. In the amended table only such time actually incurred by the regular or basic crew on coal-unloading operations has been so charged. Operating wages for 1943 remain high and unchanged, however, as no coal to speak of was charged to the boilers for this year; the conveyer crew remained therefore a straight charge against coal-unloading operations.

UNIT OPERATING COSTS

	1943	1944	1945	1946	Approx. cost	1947 to March 30
Operating wages, cents	3.42	0.28	0.28	0.33	0.33	..
Conveyer maintenance, cents	0.06	0.46	0.06	1.31	0.64	..
Tractor and carryalls (inc. drivers, fuel, and maint.), cents	11.27[a]	4.20	3.29	2.48	2.48	6.49
Other costs,[b] cents	1.63	0.29	0.06	0.11	0.14	0.32
Total,[c] cents per ton handled[d]	16.38	5.23	3.69	4.23	3.59	6.81[e]

[a] High due to use of rented equipment.
[b] Includes conveyer electricity, sundry other items.
[c] Costs exclude provisions for depreciation and interest on capital.
[d] Unit costs obtained by dividing total costs by total quantity of coal handled, i.e., tonnage received for storage plus tonnage moved from storage for consumption.
[e] Unit cost for moving coal from storage from far end of pile for consumption only.

The original storage-pile form or outline, 1000 ft long by 400 ft wide, was dictated largely by space limitations at the time of construction. These limitations no longer obtain so that this year the original pile is being shortened about 300 ft, and widened 100 ft, the intention being to pile to a depth of 50 ft, or greater. The effect of this procedure is to shorten the length of haul; and studies indicate that reclaiming and storage charges will be reduced by approximately 1/4 cent per ton.

Some moisture pickup from rain and snow of the coal in storage is indicated from the records of coal "as received," as compared with that "as fired." In an attempt to reduce this moisture gain due to exposure, it is intended to crown the top of the coal pile upon completion of the season's storage activities. To offset any tendency for surface run-off from the top of the pile to channel the side slopes, they are being rolled and compacted by the bulldozer as the pile takes shape. The final capping will be laid down to a depth of 10 to 12 in. with 1 1/2 in. × 1 in. nut coal to reduce dusting and windage loss.

COMMENT BY K. F. PARK[17]

The writer had the privilege of making the first analysis recommendation and sale of the tractor-scraper combination for storage and recovery of coal and has since made many more. The Buffalo General Electric Company was the first power company to use this combination, followed about 3 years later by the Oswego recommendation. Dow Chemical had considered an application prior to this time, but did not purchase until later.

It might prove helpful if data were given on compaction and weight figures which are lacking in the present paper. The compaction of coal with tractor equipment is due not so much to the weight of the unit as to its ability to mix large and small particles uniformly, plus vibration which settles the particles into tighter volume. A bulldozer-equipped D8 tractor (131 bhp) weighs about 40,000 lb and has but 9 lb unit pressure per sq in. on the coal surface. Heavy rollers with greatly increased unit pressure will not compact the coal as well as the bulldozers. The rubber-tired scraper has unit pressures of about 40 to 60 psi but has only about 1000 sq in. of ground contact compared to a D8 tractor's 4300 sq in. It compacts the coal, but only in comparatively small tracks A great deal of the benefit of this application further lies in the characteristic shallow spread in long, flat, controlled layers. The efficiency of the machine is not impaired by placing coal, for storage, in 6 or 8-in. layers, and the unloading process itself creates a mix which is highly desirable, causes further compaction, and simplifies the shaping and placing of the material.

It is possible in coal-storage work to increase the scraper size with any given tractor power over that of earth handling, or inversely place reduced tractor power on any size scraper. This is occasioned by the weight of loose coal which is about one half that of loose soil, since there is a direct ratio between the pounds of material a tractor will load and its usable drawbar pull in pounds. This results in a high performance efficiency and thus low costs. Maintenance is materially reduced over the costs of earth handling, being reflected in a low figure for this phase of the application, plus the probability of a considerably longer operating life.

Loose coal weighs approximately 50 lb per cu ft, and rarely exceeds 58 by other storage methods. Compacted by bulldozers the same coal will weigh from 60 to 70 lb. Placed by scrapers, about the same weight will result, which may be increased slightly if placed in thin layers and the machinery continually routed over new surfaces.

The Commonwealth-Edison plant is using tractor-scrapers plus a heavy watering by hose. Two drum sheep's foot rollers are used also. The compacted weights run from 76 to 80 lb per cu ft.

With such compactions, there naturally results the possibility of a proportionate increase of storage tonnage in any given area.

The most critical portions of a storage pile are the slopes where some segregation is certain. Bulldozers should run up the slope and back down, thus helping seal the surface. A tight seal with a layer of fines prevents all possibilities of oxidation. An additional layer of larger coal to prevent wind and water erosion gives complete protection inside and out.

Bulldozer performance is considerably increased by the addition of the following features: (1) Wings on a flare at the bowl ends. These should clear slightly when the blade is resting on the ground They should be about 1 1/2 ft wide and bowl high. (2) Raise the height of the bowl about 1 ft at the ends and about 2 ft

[17] Consulting Engineer, Caterpillar Tractor Company, Peoria, Ill.

in the center. Use a heavy steel plate and weld to the top of the bowl. The capacity of the bowl is increased considerably with these additions and so increases production materially.

A further economy for small plants lies in combining a scraper and bulldozer application on one tractor. This eliminates the need for two tractors for operations typical of either bulldozer or scraper separately, since either may be dropped temporarily, or alternately used while in combination.

A Commonwealth and Southern Corporation engineer has stated, "equipment (a scraper) having a capacity of approximately 18 cu yd per load will handle approximately 1000 tons per 8 hr for a distance of 400 to 500 ft at a total cost, both fixed and operating, not exceeding 5 cents per ton."

AUTHORS' CLOSURE

The contributions of Messrs. Coalwell, Dill, and Park add useful information to the original paper; the authors are grateful for the confirmation which this information lends to the suggestions which they advanced regarding coal handling by means of earth-moving equipment. Unfortunately, actual figures for the compacted weight of the coal in place are not available but the unit weight is believed to be well over 60 lb per cu ft. Reference to another paper by the junior author[18] will show that a maximum compacted weight of 69 lb per cu ft might be expected of the coal used at the Polymer plant; this figure agrees well with the values quoted by Mr. Park. The authors wish to express their special indebtedness to Mr. Dill not only for bringing up to date and correcting the unit costs given in the original paper but also for presenting the paper so ably at the Chicago meeting of the A.S.M.E. in their own unavoidable absence.

R. L. HEARN.[19]
R. F. LEGGET.[20]

[18] "Clogging of Bituminous Coal in Bunkers," by R. F. Legget, Trans. A.S.M.E., vol. 69, July, 1947; pp. 525–533, see Fig. 6.

[19] General Manager and Chief Engineer, Hydro-Electric Power Commission of Ontario, Toronto, Ontario, Can.

[20] Now Director, Division of Building Research, National Research Council, Ottawa, Ontario, Can.

REVIEWS OF BOOKS

And Notes on Books Received in the Engineering Societies Library

I.M.E. Centenary Volume

A History of The Institution of Mechanical Engineers, 1847–1947. Centenary Memorial Volume. By R. H. Parsons. Published by The Institution, London, England, 1947. Cloth, 6 × 9¾ in., 299 pp., illus., 15s 6d.

REVIEWED BY ARTHUR M. GREENE, JR.[1]

TO ONE who has been interested for many years in the history of engineering, its advancement in theories and practices, its machines and processes, its practitioners and constructors, the reading of this memorial volume has given special pleasure in recalling personalities with whose professional achievements he has been familiar and also the events which mark the miles along the road of engineering progress. It has given him knowledge of the growth and development of the Institution.

The seventeen chapters cover the history of the development of the Institution, sketches of the lives of some of its notable presidents, special activities of the Institution such as its James Watt International Medal and the Benevolent Fund and selections from the topics of discussion at the meetings during this period.

The history and activities of the Institution have been abstracted from the Memorial Volume by its author, Mr. Parsons, and appear in MECHANICAL ENGINEERING for October, 1947, pages 841 and 842. In this he has not considered the topics of discussion which he has cited in his book and so the reviewer has selected some from the first fifty years which give the state of engineering at different periods and indicate that some of our recent developments were thought of if not developed by the early members of the Institution.

The six chapters on Topics of Discussion show the development of mechanical engineering from the days of trial and error to the days of theoretical designs with only preliminary pilot plants or tests on models to check theory or supply constants for the final design. Each of the first five chapters covers a decade while the sixth chapter discusses the changes which have occurred in the types of papers read before the Institution during the last fifty years. In these chapters a number of reproductions of illustrations used in the original papers show the forms of structures described and give a clearer idea of the state of mechanical engineering at those times.

The early papers were "mainly of a descriptive kind, written with the object of bringing some new engineering work to the notice of the members in order that it might form the subject of a useful discussion." The first paper in 1847 by James Buckle, discussed the design of centrifugal fans in view of the results of experiments at the Soho Works of James Watt and Company. He suggested the use of several fans in series to replace blowing engines for blast furnaces. Some fans were proposed for mine ventilation to replace the ventilating furnaces which produced the draft in upcast shafts. The paper of T. J. Taylor in 1859 indicated that the efficiency of the furnaces as air movers was about one half of one per cent but the author considered that no system of mechanical ventilation offered greater advantages. A paper by Daniel in 1875 on the Cooke Ventilating Machine, an immense rotary air pump, indicated that at that time there were 250 mechanical ventilating systems mostly using centrifugal fans with diameters of 30 or 40 feet.

The action of centrifugal pumps was the first paper with a mathematical treatment and in it differential calculus first appeared in the Transactions. It was presented by Prof. Andrew J. Robertson in 1853.

The only paper written by the first president, George Stephenson, appeared in 1848 shortly before his death. Its title, "On the Fallacies of the Rotary Engine," indicated his thoughts regarding a rotary engine which was to be described at the meeting. In this he pointed out that there was no loss in power when reciprocating motion was changed into rotary motion in the ordinary steam engine. He had no use for the rotary engine and would not attend any trials of them on trains or

[1] Dean Emeritus, School of Engineering, Princeton University; Consulting Engineer Princeton, N. J. Fellow and Hon. Mem. A.S.M.E.

vessels. The discussion at the meeting brought out the facts that there were a number of rotary engines at this time in operation but they all lacked steam tightness of the moving rotors. The experience of the intervening century has not changed the picture.

The gradual increase of steam pressure for prime movers is shown in many papers beginning with 1848 when James Craddock claimed that although low pressures were used 200 psi was feasible and that compounding should be used to reduce the range of temperature in one cylinder and to give a better turning moment. The pressure which he suggested did not come into general use for forty years. In 1855 E. E. Allen advocated greater expansive use of steam in marine engines. The merchant vessels of that day used steam at 20 psi with cutoff at $^3/_4$ stroke, using $4^1/_2$ lb of coal per ihp-hr. The Admiralty had several gunboats at this time using steam at 50 to 60 psi. Even by 1881, according to F.C. Marshall in his paper on the progress in marine engineering from 1872 to 1881, the pressure had only reached 90 psi and three-cylinder compound engines were coming into use. In the next decade Alfred Blechynden reports that pressures reached 200 psi with triple-expansion engines and forced draft. In some cases superheated steam was used.

Steam pressure of 500 psi was reported by Williamson and Perkins in 1861 using a special water-tube boiler and a triple-expansion engine with cylinders in the boiler gas stream and a feedwater heater using the flue gas. This unit of engine and boiler produced a horsepower-hour on $1^1/_2$ lb of coal. Perkins again described the unit in 1877.

The examination of boiler explosions by E. B. Marten in 1866 and also in 1870 indicated that these were due to simple causes such as faulty construction or repair or to conditions avoidable by periodic inspection. He urged that inspection be made compulsory.

In 1869 T. R. Crampton discussed his experiments with pulverized coal as a boiler fuel.

The tests of portable farm steam engines and boilers for awards by the Royal Agricultural Society were reported by William Waller in 1856 and W. E. Rich in 1876. These reports described the improvements in design and efficiency resulting from these competitions and also the developments in the instruments used to measure performance.

In 1857 Sir Joseph Whitworth read his paper "On a Standard Decimal Measure of Length for Mechanical Engineering Work" advocating the use of decimals in place of fractions. He exhibited his go and no-go gages differing by one ten thousandth of an inch. Although the Institution approved his suggestion few builders and designers were willing to adopt it.

Air-conditioning of St. George's Hall in Liverpool in 1854 was described in 1863 by William Mackenzie. In this installation air was warmed or cooled, cleaned and humidified for the whole building using 7 to 10 cfm per person.

One of the important papers was that of Monsieur Arthur Achard in 1881 on "Various Modes of Transmitting Power to a Distance." In this he describes systems and lists them in order of preference: wire rope, compressed air, hydraulic transmission, and electrical transmission. In the discussion of the paper mention was made of the use of steam at Hartford, Connecticut, and long reciprocating rods in the mines of Cornwall and Devonshire. Sir William Siemens referred to a private electrical transmission used by Sir William Armstrong and him.

The establishment of the Research Committee of the Institution in 1879 and its subcommittees led to the presentation of many valuable reports in the years to follow. For the subcommittee on friction between solid bodies at high velocities the reports of 1883 and 1885 which gave the results of the famous experiments of Beauchamp Tower were great contributions of value to all designers of moving devices. Reports on steel in 1882, 1883, and 1885 and on alloys in 1891 cleared up questionable matters in metallurgy. Reports were made in 1889, 1890, and in 1894 by the Research Committee on Marine Engine Trials and in 1889 and 1892 reports were made on Steam Jackets Research. Other important reports have been issued by research committees during the last half century in which desired data for the profession have been given.

The temperature-entropy diagram for the analysis of steam-engine performance was described by John Macfarlane Gray in 1889 although he had used it for ten years and in 1894 Captain Riall Sankey used it to illustrate the performance of the engines of the report of the Marine Engine Trials Research Committee.

In 1888 Sir Charles Parsons presented his paper on the steam turbine which included drawings of two units, one of 16 kw capacity and the other of 32 kw. Tests showed steam consumptions of 42 lb per ehp-hr with steam at 61 psi and 35.1 lb per ehp-hr when the pressure was raised to 92 psi. Mr. Jeremiah Head, president of the Institution, in discussing the paper wondered if hot gases from the combustion of petroleum could not be used as the motive substance eliminating the boiler and also if the turbine might not be used for aerial navigation because of its low weight.

In 1879 J. H. Greathead advocated high-pressure fire mains with pressures of 800 to 1000 psi extending from many fire stations.

The book is excellently illustrated and printed and contains extensive subject and name indexes as well as chronological lists of the important events of the Institution during the century and the distinguished presidents under whom it has grown.

Metals and Plastics

METALS AND PLASTICS—Production and Processing. By Thomas P. Hughes: Irwin-Farnham Publishing Co., Chicago, Ill., 1947. Cloth, 6 × $8^7/_8$ in., 373 pp., 186 illus., 86 tables, $4.50.

REVIEWED BY W. TRINKS[2]

PROFESSOR HUGHES (University of Minnesota) wrote this book as a textbook for university students, intending "to present a comprehensive perspective of manufacturing processes with a detailed study of some of the more common materials, alloys, and plastics, so that the student will have an understanding of their fundamental potentialities and a basis for selection."

The following subjects are treated: Metals and their internal structures, 12 pages; equilibrium diagrams, 10 pages; physical properties of metals, 20 pages; manufacture of iron, 10 pages; casting processes, 24 pages; ferrous castings, 28 pages; nonferrous metals and alloys, 24 pages; iron, iron-carbide diagram, 12 pages; heat-treatment of steels, 46 pages; mechanical working of metal, 42 pages; welding, 48 pages; brazing, 6 pages; plastic materials, processes, and uses, 20 pages; classification of steels, 10 pages; appendix (which contains miscellaneous, very useful, information), 30 pages.

Professor Hughes' book contains information not only on the older sciences of chemical metallurgy and process metallurgy, but also on the more modern phases of metallurgy and of plastics technology.

While the book is written for college students, it may be even more useful for mechanical engineers whose university training was built around the so-

[2] Consulting Engineer, Associated Engineers, Pittsburgh, Pa. Mem. A.S.M.E.

called fundamentals, around machine design, thermodynamics, power plants, and social relations. To such men the words spheroidizing, austempering, bainite, S-curves, grain size No. 5, submerged arc welding, ureaformaldehyde, and so on, mean nothing. They will profit by studying the book and by attempting to answer the questions which follow each chapter. Being an elementary textbook it treats each subject rather briefly. For those who wish to go into any one of the subjects more thoroughly, a very complete bibliography is given at the end of each chapter. The glossaries on metallurgical and foundry terms will be helpful to many mechanical engineers.

For the publishers it may be said that the printing is excellent.

Management Leader's Manual

THE MANAGEMENT LEADER'S MANUAL FOR OPERATING EXECUTIVES, SUPERVISORS, AND FOREMEN, No. 1. American Management Association, New York 18, N. Y., 1947. Spiral bound in blue leatherette, 5 1/2 × 8 1/4 in., 190 pages, $3.

REVIEWED BY HAROLD R. NISSLEY[3]

THIS "handbook" of 190 pages is a compilation of A.M.A.'s previously published papers on supervisory problems. Although it was designed to bring management principles to a larger number of foremen and superintendents than are now reached by the American Management Association, its style and content would lend itself well as a teacher's manual in conducting classes in training in supervision. This Number One volume is broken down into seven major parts.

Part 1, captioned "Management Leadership in a Democracy," contains a series of papers by various specialists on such subjects as: the essentials of democratic leadership in a democracy, how to develop democratic work teams, supervisor's management job, spotting the symptoms of inadequate supervision, and others.

Specific shop problems are intelligently handled as in the following situations:

"He (the foreman) sees that newcomer Sam is pretty much of an outsider yet so far as feeling at home is concerned in the work group; so he enlists the aid of Jim, the natural leader of the group, to take a friendly interest in seeing that Sam gets pulled into things more at lunch hour. He recognizes that Nate feels quite insecure about his work and needs more recognition than the others, but he realizes he will only make it worse for Nate if the special attention should look like favoritism. He notices the little clique in the corner whose members are becoming rather lax in some of their work habits; the supervisor knows Max is the person who is "listened to" in that subgroup, so he has a friendly personal chat with Max and the problem disappears. To sum it up, this supervisor knows: (1) that in a democratic work group social control of the individual can usually come best from within the group itself; and (2) that every personal contact with a worker must be thought of in terms of its possible group implications."

In Part 2 under such headings as "How to Give Workers a Sense of Security," "Principles of Disciplining," and "Talking Your Ratings" the management leader's human-relations responsibilities are considered. A few cases illustrating what happens when poor leadership is substituted for good leadership are also given. In Part 3, interviewing and counseling techniques as discussed. Parts 4 and 5 take up such matters as supervisory control for safe and efficient production, the supervisor as key man in accident prevention, meeting some common problems in teaching, and training in work simplification.

Several tests useful to the management heads are given in Part 6. These tests have a decided college classroom flavor, not only in subject matter covered but in language used. They do, however, point the way to modern objective tests—true and false, multiple choice, completion, and matching questions. Tests like these should be less of the "encyclopedia" and have more of the "shop" variety questions.

Suggestions for improving written communications, diagnosing organization problems, as well as a guide to good work relations are given in Part 7.

By and large "The Management Leader's Manual" is a good treatment of a key problem in management—improving the quality of supervision. Any defects it possesses lie largely in omission rather than commission. More shop situations should be used to illustrate the principles. Questions at the end of each section would help in "nailing down" points made in the text. A list of visual aides would help in teaching a foreman-training course (see "Recommended Visual Aides for Supervisors" in the August, 1947, issue of *Factory Management and Maintenance*). A short bibliography at the end of each section would help. Finally, a few important omissions in subject matter should be mentioned, such as time study and production standards, and introducing and training the new worker in his job.

[3] Industrial Relations Division, Lamp Department, General Electric Company, Cleveland, Ohio.

Anatomy of Depreciation

ANATOMY OF DEPRECIATION. By Luther R. Nash. Public Utilities Reports, Inc., Washington, D. C., 1947. Cloth, 5 1/2 × 8 in., 214 pp., illus., $5.

REVIEWED BY STEWART L. FERGUSON[4]

IN this book the author writes from his experience during many years as a member of various accounting and depreciation committees and his close study of utility matters. He presents the history and development of depreciation and retirement accounting, with reference to the controversial aspect in the application of rigid formulas in making provision by utilities for the ultimate retirement of property. The book contains such significant chapters as Service Lives, Straight-Line Method, Interest Methods, Reserve-Size Method, and Relative Advantages of Available Methods. A review of this book's discussions discloses sundry references to precision methods, with questions as to their appropriateness in determinations of current and accrued depreciation.

[4] Property Engineer, The Detroit Edison Company, Detroit, Mich.

Books Received in Library

BLUEPRINT LANGUAGE OF THE MACHINE INDUSTRIES. By H. C. Spencer and H. E. Grant. Macmillan Company, New York, N. Y., 1947. Cloth, 9 1/2 × 11 1/2 in., 255 pp., Blueprints, diagrams, charts, tables, $5. Profusely illustrated by drawings and simple blueprints from actual commercial and industrial use, this manual provides fundamental training in blueprint reading. Emphasis is placed upon the visualization of views of objects, and "completion problems" are extensively used to enable coverage of a wide range in a relatively limited time.

CONTRACTS IN ENGINEERING. By J. I. Tucker. Fourth edition. McGraw-Hill Book Co., Inc., New York, N. Y., and London, England, 1947. Cloth, 5 1/4 × 8 1/2 in., 341 pp., tables, $5. This textbook of legal principles for students, engineers, contractors, and business men covers the interpretation and writing of engineering-commercial agreements. The object of the book is to explain the fundamentals underlying a variety of cases and situations so that the guiding principles will be recognizable. A detailed index and several groups of study and review questions add to the practical value of the book for self-study.

DIRECTORY OF STEEL FOUNDRIES in the United States and Canada. Steel Founders' Society of America, Cleveland, Ohio, July, 1946. Paper, 177 pp., 9 × 6 in., $10. The steel foundries of the United States and Canada are listed alpha-

betically in Sections 1 and 2 respectively. The information given includes personnel, type and size of castings produced, available melting and annealing equipment, number of employees, and capacity figures. An index of United States foundries by States is included as Section 3.

ESSENTIALS OF APPLIED PHYSICS. By R. M. Frye. Prentice-Hall, Inc., New York, N. Y., 1947. Cloth, 6 × 9¼ in., 322 pp., diagrams, tables, $4. An elementary physics textbook requiring a mathematical basis of algebra, geometry, and trigonometry. The general procedure of mechanics, heat, sound, electricity, and light is followed. Each chapter is summarized on the basis of definitions of the technical terms and laws introduced. The practical electrical units are used and the electron current is employed exclusively rather than the conventional positive current.

ELEMENTARY FLUID MECHANICS. By J. K. Vennard. Second edition. John Wiley & Sons, Inc., New York, N. Y.; Chapman & Hall, London, England, 1947. Cloth, 5½ × 8¼ in., 339 pp., illus., diagrams, charts, tables, $4. Fundamentals, physical properties, and fluid statics are discussed in the beginning chapters, followed by a chapter on frictionless flow to lay the groundwork for a number of important principles arising therefrom. The principles of similarity and dimensional analysis are similarly considered, as important tools for future use. The discussion of frictional processes leads to flow in pipes and open channels, and fluid measurements are dealt with. Considerable revision, including some condensation and the deletion of certain advanced topics, resulted in a shorter book despite the normal addition of recent developments. The principal change is the expansion of the original chapter on ideal fluid flow.

ENGINEERING ORGANIZATION AND METHODS. By J. E. Thompson. McGraw-Hill Book Co., Inc., New York, N. Y., and London, England, 1947. Cloth, 6 × 9¼ in., 337 pp., illus., diagrams, charts, tables, $4. This book furnishes industrial executives and supervisors with tested techniques for speeding up production and reducing costs in product-design engineering departments. Offering a specific fundamental plan for organizing, operating, and controlling these departments, it describes practical methods which have been used successfully in both large and small engineering sections of a wide variety of technical concerns. The book supplies the complete data necessary for the orderly preparation, processing, and recording of engineering information, and also includes a useful, general discussion of the functions of supporting departments.

Library Services

ENGINEERING Societies Library books may be borrowed by mail by A.S.M.E. members for a small handling charge. The Library also prepares bibliographies, maintains search and photostat services, and can provide microfilm copies of any item in its collection. Address inquiries to Ralph H. Phelps, Director, Engineering Societies Library, 29 West 39th St., New York 18, N. Y.

FORUM ON DIESEL FUEL OILS. Technical Publication No. 71, sponsored by Technical Committee F of Committee D-2 on Petroleum Products and Lubricants, American Society for Testing Materials, Nov. 13, 1946, at Chicago, Ill. American Society for Testing Materials, Philadelphia, Pa., 1947. Paper, 38 pp., charts, tables, $0.75 to A.S.T.M. members, $1. otherwise. The purpose of this forum was to have representatives of the consumers and the producers of Diesel fuels and the manufacturers of Diesel equipment discuss current problems, stressing the importance of co-operative research. The seven papers, of a general, nontechnical nature, present various phases of the oil and engine industries, and include numerous statistics on recent trends in distillate fuel production.

GERMAN HEAT RESISTANT STEELS, report made by A. Field. 9 pp., $1. GERMAN TECHNIQUE IN THE PRODUCTION OF LIGHT ALLOYS, reported by P. M. Haenni and T. J. Peake. 22 pp., $2. OPEN-HEARTH PRACTICE AT GUSS-STAHLFABRIKATION (PB-4267), Combined Intelligence Objectives Sub-Committee, Section 21, Metallurgy, report on Black List Target No. 21/9, 8 pp., apply for price. REPORT ON RECOVERY OF VANADIUM FROM IRON AND STEEL PLANT SLAGS, CIOS Sub-Section, Inf. Sec. Int. Div. OCE, TSFET, APO 887, U. S. Army. 10 pp., $1. Hobart Publishing Company, Bond Building, Washington 5, D. C., Paper, 8½ × 11 in. Four reports, now released, which cover various aspects of German research and practice in ferrous and nonferrous metallurgy. The one on light-alloy production covers both metallurgical and manufacturing procedures.

HOT-WATER HEATING AND RADIANT HEATING AND RADIANT COOLING. By F. E. Giesecke, New Braunfels, Texas, 1947. Apply to author or Technical Book Co., 110 E. 9th St., P.O. Box 62, Austin, Texas. Cloth, 6 × 9¼ in., 283 pp., illus., diagrams, charts, tables, $4. This practical work is chiefly concerned with actual design and installation procedures for particular types and cases of hot-water heating, radiant heating, and radiant cooling. All necessary graphs and calculations are included and illustratively used. Separate chapters are devoted to the heat requirements of buildings, heat emission of radiators and panels, distinctions between open and closed systems, district heating, and radiant heating and cooling fundamentals.

INJECTION MOLDING OF PLASTICS. By I. Thomas. Reinhold Publishing Corporation, New York, N. Y., 1947. Cloth, 6 × 9¼ in., 534 pp., illus., diagrams, tables, $10. The book is at once a simplified text for the layman, a handbook of technical data, and a complete survey of injection molding and the plastics industry. It contains charts of the physical properties of many plastics, the history and development of the industry, and information about the design, construction, and finishing of plastic products. Information is given on estimating costs and on safety practices.

INTRODUCTION TO THE THEORY OF EQUATIONS. By L. W. Griffiths. Second edition. John Wiley & Sons, Inc., New York, N. Y.; Chapman & Hall, Ltd., London, England, 1947. Cloth, 5½ × 8½ in., 278 pp., diagrams, tables, $3.50. The important general theorems in the elementary theory of algebraic equations are developed from the particular to the general. Complicated proofs are separated into simpler parts for easier understanding, and other such clarifying procedures are used wherever it seems needful. Determinants and complex numbers are also dealt with.

INVENTIONS AND THEIR MANAGEMENT. By A. K. Berle and L. S. de Camp. Second edition. International Textbook Co., Scranton, Pa., 1947. Cloth, 5 × 8½ in., 742 pp., illus., diagrams, charts, tables, $6. ($5 College edition.) This comprehensive work presents the principles and practices governing the technical, legal, and business procedures of invention, from the history and theory of the protection of ideas to the methods of exploitation. Numerous illustrative cases from actual experience are given. Foreign patents, trademarks, and copyrights are discussed, and a glossary and a detailed index are included. The new edition contains a discussion of the Lanham Act and a new chapter on trends in industrial research and invention.

MACHINERY FOR WINNING AND LOADING OF BITUMINOUS COAL UNDERGROUND, PB-1829, 4 pp. MANUFACTURE OF WIDIA BITS FOR CHAIN COAL-CUTTING MACHINES, PB-4359, 3 pp. MINING METHOD FOR A FIVE-FOOT SEAM, Pitch 25 deg to 50 deg, Mine Fritz, Hoesch A.G., Essen, PB 23755, 4 pp. MINING METHOD FOR A FIVE-FOOT SEAM, Pitch 60 deg, PB-1828, 5 pp. OPERATION OF COMPRESSED AIR SHEARING MACHINE, Mine Furst Hardenberk, Gelsenkerken, B.A.G. PB-1824, 4 pp. OPERATION OF PNEUMATIC PACKING MACHINE AND SCRAPER LOADER WITH PLANER, PB-1823, 3 pp. Present Status of COAL SHEARING MACHINE DESIGN, PB-4345, 3 pp. OPERATION OF THE COAL PLANER, Mine Hannever-Hannibal (Krupp), Essen-Ruhr, PB-4344, 4 pp. Hobart Publishing Co., Washington 15, D. C., $1. each. This series of small pamphlets describes briefly various procedures and types of equipment as observed in the German coal industry.

MANUAL OF ENGINEERING DRAWING for Students and Draftsmen. By T. E. French, revised by C. J. Vierck. Seventh edition. McGraw-Hill Book Co., Inc., New York, N.Y., and London, England, 1947. Cloth, 6 × 9½ in., 694 pp., diagrams, charts, tables, $3.75. This revised and enlarged edition contains the usual information on instruments, drawing, dimensioning, sketching, perspective, maps, charts, graphs, and diagrams. A new chapter on illustration has been added, the chapter on perspective was revised considerably, and the chapter on dimensioning expanded. Several new projective methods and explanations have been included. When using this volume as a text, the author suggests the use of the McGraw-Hill Text-Films which were made specially to be companion material to the book.

PETROLEUM PRODUCTION, Vol. 3. Oil Production by Water. By P. J. Jones. Reinhold Publishing Corporation, New York, N. Y., 1947. Cloth, 6 × 9¼ in., diagrams, charts, tables, $5. Continuing the series by this author, the present volume is limited to oil production by water, covering the following

principal factors: convergence, fluid factors, invasion factors, displacement factors, and well-interference factors. Two contours, called the breakthrough and maximum recovery contours, are used in estimating cumulative oil recovery and producing rates. The applications of these basic factors and limiting features to various types of reservoirs are effectively detailed, using statistical procedures which reduce the numerous variables to a comparative few, and taking into account economic as well as physical conditions.

SEQUENTIAL ANALYSIS. By A. Wald. John Wiley & Sons, Inc., New York, N. Y.; Chapman & Hall, London, England, 1947. Cloth, 6 × 9¼ in., 212 pp., diagrams, charts, tables, $4. A full discussion is offered of the new statistical technique known as the Sequential Probability Ratio Test. The author explains the fundamental theory, the applications, and potentialities of this method of analysis. Among the advantages stated, as against other procedures for testing a statistical hypothesis, is that it "controls the possible errors committed by a wrong decision as effectively as the best current procedure based on a predetermined number of observations, yet it substantially reduces the number of observations necessary." Comparison with other procedures is made, and through a discussion of possible approaches to problems a groundwork is provided for further research.

SYMPOSIUM ON ATMOSPHERIC WEATHERING OF CORROSION-RESISTANT STEELS, presented at the 49th Anual Meeting, American Society for Testing Materials, Buffalo, N. Y., June 24–28, 1946. American Society for Testing Materials, Philadelphia, Pa., 1947. Paper, 6 × 9 in., 85 pp., illus., diagrams, charts, tables, $1.50. Through the seven papers included is brought together in convenient form an up-to-date picture of the behavior of the so-called stainless steels when exposed to the atmosphere in various shapes and under varying conditions. Numerous illustrations and tables increase the practical and ready application of the information presented.

SYMPOSIUM ON TESTING OF PARTS AND ASSEMBLIES. Technical Publication No. 72, sponsored jointly by American Society for Testing Materials and Society for Experimental Stress Analysis, presented at the 49th Annual Meeting, American Society for Testing Materials at Buffalo, N. Y., June 26, 1946. American Society for Testing Materials, Philadelphia, Pa., 1947. Paper, 6 × 9 in, 86 pp., illus., diagrams, charts, tables, $1.50; to A.S.T.M. members, $1.15. This symposium is one of a series which has been planned to promote a better knowledge on the correlation of testing and serviceability and insure the validity of resulting test methods. Six papers, mainly concerned with fatigue strength determinations, are included.

WELDING ENCYCLOPEDIA, completely revised and re-edited by T. B. Jefferson, originally compiled and edited by L. B. Mackenzie. Twelfth edition. Welding Engineer Publishing Co., New York, N. Y., 1947. Fabrikoid, 5½ × 9 in., 1024 pp., illus., diagrams, tables, $6.50. From abrasion to zirconium this standard reference work covers all terms relating to the broad field of metal joining and cutting by the application of heat, including heat-treating processes and other allied subjects. Photographs, line drawings, graphs, data tables, and equilibrium diagrams are extensively used to illustrate or amplify the text. Various pertinent codes, standards and specifications are appended, and there is a 90-page list of trade names with descriptive information. The volume has been revised throughout in accordance with current practice.

WRITING THE TECHNICAL REPORT. By J. R. Nelson. Second edition. McGraw-Hill Book Co., Inc., New York, N. Y., and London, England, 1947. Cloth, 5½ × 9 in., 388 pp., diagrams, tables, $3. The first part of the book presents a review of those fundamental considerations which bear on the design and composition of the report. The second gives specific directions for the setup of the report, with several illustrative reports of both the long and short form. The third outlines a systematic procedure for the critical examination of a report, and the last part suggests a series of assignments for those who wish to use the book as a classroom text. Although little changed essentially from the earlier edition, the book now contains an index.

ZÜRICH, SWITZERLAND, EIDENÜSSISCHE TECHNISCHE HOCHSCHULE, INSTITUT FÜR AERODYNAMIK. Mitteilung No. 10, Untersuchungen an Verdichtungsstössen und Grenzschichten in schnell bewegten Gasen, by J. Ackeret, F. Feldmann and N. Rott. 56 pp., 8 Sw. fr. Mitteilung No. 11, Beitrag zur Theorie festesthender Schaufelgitter, by R. Meyer. 100 pp., 12 Sw. fr. Mitteilung No. 12, Experimentelle Untersuchungen an einer axialen Gebläsestufe, by E. Mühlemann. 71 pp., 10 Sw. fr. Mitteilung No. 13, Untersuchungen über Reibungsverminderungen an Tragflügeln, insbesondere mit Hilfe von Grenzschichtabsaugung, by W. Pfenninger. 108 pp., 14 Sw. fr. Verlag Ag. Gebr. Leemann & Co., Zürich, Switzerland, 1946. Paper, 6¾ × 9¼ in., illus., diagrams, charts, tables. Issued last year by the Swiss Federal Institute for Aerodynamics, these four publications cover research on the following aspects of the field: Investigations on compression shocks and boundary layers in rapidly moved gases; contribution to the theory of a fixed blade lattice; experimental investigations on an axial blower stage; investigations on friction reduction in supporting wings, particularly with the help of boundary-layer suction. Diagrams, charts, and tables have been extensively used for the more effective presentation of the included information.

Zürich, Switzerland, Eidgenössische Technische Hochschule, Institut für Baustatik Mitteilung No. 20, STABILITÄT DER PLATTEN IM PLASTISCHEN BEREICH, Theorie von A. Iljuschin mit Vergleichswerten von durchgeführten Versuchen. By C. F. Kollbrunner and G. Herrmann. Verlag Ag. Gebr. Leemann & Co., Zürich, 1947. Paper, 6 × 9 in., 81 pp., diagrams, charts, tables, 12 Sw fr. This communication from the Swiss Federal Institute of Structural Research presents an analysis of the stability of plates in the plastic region. It considers the application of the theory to plates stressed by uniformly distributed pressure on one side and makes comparisons with results of actual tests. The conclusions reached are summarized and there is a brief bibliography.

A.S.M.E. BOILER CODE

Proposed Revisions and Addenda to Boiler Construction Code

IT IS the policy of the Boiler Code Committee to receive and consider as promptly as possible any desired revisions of the rules and its codes. Any suggestions for revisions or modifications that are approved by the Committee will be recommended for addenda to the code, to be included later in the proper place.

The following proposed revisions have been approved for publication as proposed addenda to the code. They are published herewith with corresponding paragraph number to identify their location in the various sections of the code and are submitted for criticism and approval from anyone interested therein.

It is to be noted that a proposed revision of the code should not be considered final until formally adopted by the Council of the Society and issued as pink-colored addenda sheets. Added words are printed in SMALL CAPITALS; words to be deleted are enclosed in brackets [ ]. Communications should be addressed to the Secretary of the Boiler Code Committee, 29 West 39th St., New York 18, N. Y., in order that they may be presented to the Committee for consideration.

PAR. P-9(a). Add reference to Grade C3A after Specification SA-157 in the ninth line.

TABLES P-7 AND U-2. Delete references to SA-70 and SA-89; for SA-285 the same stresses will apply for Grades A and B as for Grades A and B of SA-89, for Grade C the same stresses as for SA-70. For Specifications SA-53 and SA-106 delete the reference to Note (3), add a reference to Note (14), and add the following Note:

(14) These stresses permitted for open-hearth and electric-furnace steel only provided 0.10 per cent minimum silicon is expressly specified. Add the following stresses for the grades indicated for SA-27 and SA-30:

TABLES P-5 AND U-4. For Specifications SA-53 and SA-106 delete the reference to Note (3), replace it by a reference to Note (5) to read as follows:

(5) These stresses permitted for open-hearth and electric-furnace steel only provided 0.10 per cent minimum silicon is expressly specified.

SPECIFICATION SA-83. Revise note to read:

(NOTE: Tubes [for unfired pressure-vessels] complying with A.S.T.M. Specifications A 179-46 [A 179-42] ordered to minimum wall thickness, will be acceptable as complying with the intent of Specification SA-83.)

A.S.M.E. NEWS

And Notes on Other Engineering Societies

COMPILED AND EDITED BY A. F. BOCHENEK

Tentative Program of The A.S.M.E. 1947 Annual Meeting, Atlantic City, N. J. Dec. 1 to 5

Headquarters: Chalfonte-Haddon Hall Hotels

IN planning its 1947 Annual Meeting for Dec. 1 to 5, 1947, at the Chalfonte-Haddon Hall Hotels, Atlantic City, N. J., one of America's famous winter resort centers, The American Society of Mechanical Engineers has not altered the essential business and technical character of its principal meeting.

The meeting will be true to tradition, packed with 74 technical sessions, one more than in 1946, at which more than 200 papers covering latest developments and research in the field of mechanical engineering will be presented. But mindful of the hectic Annual Meetings of the past few years, the program this year was extended over a five-day period, evening sessions were avoided to ease the pace of the meeting.

From a program studded with concerts, movies, luncheons, dinners, demonstrations, and plant trips, it will be possible for every member to select those events whose rewards in profit will precisely answer his need.

Nonmember Registration

To enhance the value of society membership and to permit guests to contribute to the support of Society meetings, a nonmember registration fee of $5 will be inaugurated at the 1947 Annual Meeting. Guest-attendance cards formerly issued upon request of members, will be discontinued. No fee will be required from nonmember authors, immediate family of members, and nonmember student aids.

Preprints on Sale

Annual Meeting preprints are now on sale at headquarters at 25 cents each to members and 50 cents each to nonmembers. Orders received during the week prior to the meeting will not be filled until after Dec. 8. Remittances should accompany orders.

Plenty of Rooms in Atlantic City

Rooms in Atlantic City will not be as abundant as the sand on the beaches, but in comparison to the room problem in New York City, the simile may be apt. More than 2500 rooms are available for A.S.M.E. members in 17 boardwalk hotels and 21 avenue hotels including those at the Chalfonte-Haddon Hall Hotels. Most of the rooms average $5 per person. For reservations, members are asked to write to Philip E. Parlett, Chalfonte-Haddon Hall, Atlantic City, N. J.

Eminent Speakers Invited

Distinguished speakers from many fields have been invited to address the Society on problems of national importance during the ten luncheons and dinners scheduled. Among the speakers will be: David Lilienthal, chairman, Atomic Energy Commission, Washington, D. C., who will address the Nuclear Energy Luncheon on Tuesday; Fred S. McConnell, president of the National Coal Association, will speak at Tuesday Fuels Dinner on "The Coal Industry Looks Ahead;" Alvin E. Dodd, president, American Management Association, at the Management Luncheon will talk on "Productivity—Prices—Markets."

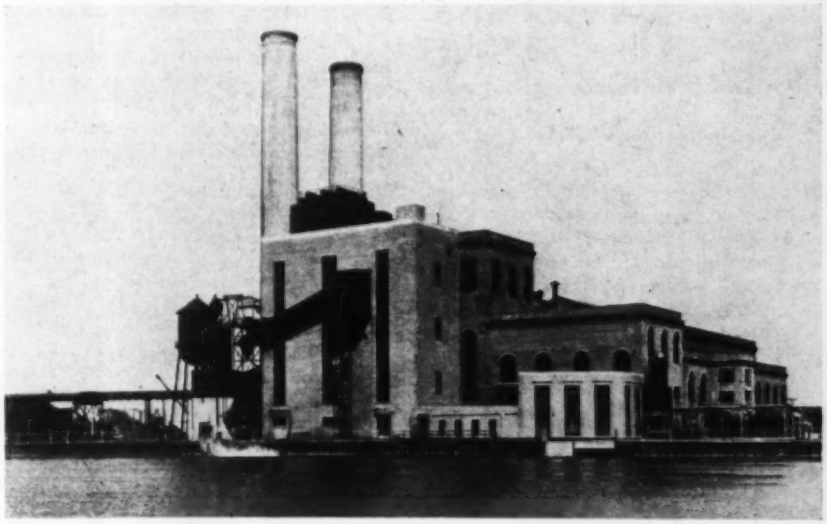
Many Honors and Awards to Be Conferred

At the banquet on Wednesday evening the Society will confer its honors and awards on engineers who have made significant contributions to the engineering profession. Those honored will be:

Honorary Membership: Everett G. Ackart, Wilmington, Del.; Harvey N. Davis, president, Stevens Institute of Technology; Francis Hodgkinson, consulting engineer, New York, N. Y., and Hon. George C. Marshall, Secretary of State, Washington, D. C.

(Honorary membership was conferred on Lord Dudley Gordon, president, The Institution of Mechanical Engineers, at the I.M.E. Centenary Celebration in June, 1947.)

A.S.M.E. Medal: Paul W. Kiefer, chief



MISSOURI AVENUE PLANT OF THE ATLANTIC CITY ELECTRIC COMPANY, ATLANTIC CITY, N. J.

CHALFONTE-HADDON HALL HOTELS, ON THE BEACH IN ATLANTIC CITY, N. J., WILL SERVE AS HEADQUARTERS DURING THE A.S.M.E. 1947 ANNUAL MEETING, DEC. 1 TO 5, 1947

engineer, motive power and rolling stock, New York Central System.

Holley Medal: Raymond D. Johnson, Fort Lauderdale, Fla.

Warner Medal: Arpad L. Nadai, consulting mechanical engineer, Westinghouse Research Laboratories, East Pittsburgh, Pa.

Melville Medal: Raymond C. Martinelli, General Electric Company, Schenectady, N. Y.

Gantt Medal: Alvin E. Dodd, president, American Management Association, New York, N. Y.

John Fritz Medal: Theodor von Kármán, director, Guggenheim Aeronautical Laboratory, California Institute of Technology, Pasadena, Calif.

Spirit of St. Louis Medal: Presented to John K. Northrop, president, Northrop Aircraft, Inc., Hawthorne, Calif., at A.S.M.E. Fall Meeting, September, 1947.

Alfred Nobel Prize: Presented to Martin Goland, chairman, engineering mechanics research, Midwest Research Institute, Kansas City, Mo., at A.S.M.E. Semi-Annual Meeting, June, 1947.

Other awards will be announced later.

Educational Exhibits

An innovation at the 1947 Annual Meeting will be an educational exhibit of equipment and material reflecting engineering and scientific developments in the field of jet propulsion, gas turbines, and nuclear energy. Among the exhibits will be a series created by James D. Mooney, member A.S.M.E., president, Willys-Overland Motors, and Walter Fried, consulting engineer, which demonstrate operation of laws of economics. Engineering principles of flow and buoyancy in combination with graphs and charts have been employed to show how economic variables affect supply and demand, commodity prices, the value of money, and the distribution of income.

A graphic arts exhibit showing the work of A.S.M.E. members and nonmembers is also planned.

Rocket-Assisted Take-Off Demonstration

At noon on Thursday, Dec. 4, the American Rocket Society will arrange a demonstration of a rocket-assisted take-off, demonstration of Army Air Force and Naval jet-propelled aircraft, and static firing of liquid-fuel rocket engines for benefit of members attending the Annual Meeting.

Watch for Circulars

Members are cautioned that the program published in this issue is a tentative program. While no major changes are contemplated, members should consult Annual-Meeting circulars already in the mails for information on how to obtain preprints of the final program. Briefly, the circulars contain a request form listing all the sessions to be held. Members are requested to indicate on the forms those sessions which are of interest to them. Upon receipt of the forms at headquarters, preprint pages of the final program covering the sessions marked will be mailed to each member.

This procedure was devised to prevent disappointment to those who may attend the meeting only to find particular papers had been canceled after the November issue of MECHANICAL ENGINEERING had gone to press.

Continuous Movies

Two interesting films "Railroad Truck Frames" and "Counter Gravity Castings" will be shown each day of the Annual Meeting. The films are sponsored by the Metals Engineering and Production Engineering Divisions.

Official Notice

A.S.M.E. Business Meeting

THE Annual Business Meeting of the members of The American Society of Mechanical Engineers will be held on Monday afternoon, December 1, 1947, at 5:00 p.m. in the Viking Room, Haddon Hall Hotel, Atlantic City, N. J., as a part of the Annual Meeting of the Society.

The Tentative Program

MONDAY, DECEMBER 1

9:30 a.m.

Applied Mechanics (I)

Vibration of a Beam With Concentrated Mass, Spring, and Dashpot, by Dana Young, professor, University of Texas, Austin, Texas.

Impact of a Mass on a Damped Elastically Supported Beam, by William H. Hoppman, II, professor, Johns Hopkins University, Baltimore, Md.

A Mechanical Analyzer for the Solution of Vibration Problems of a Single Degree of Freedom, by E. E. Weibel, professor, University of Colorado, Boulder, Colo., N. M. Cokyucel, Jr., engineer, Marchant Calculating Machine Company, Emeryville, Calif., and R. E. Blau, student, University of California, Berkeley, Calif.

Critical Shear Stress of Plates Above the Proportional Limit, by George Gerard, New York, N. Y.

Torsion of a Rectangular Tube by J. M. Klitchieff, professor, Belgrade University, Belgrade, Yugoslavia

Heat Transfer (I)

Development of the Anti-Icing System of the Fairchild "Packet," by H. Serbin, School of Aeronautics, Purdue University, Lafayette, Ind.

Flash Drying, by C. W. Gordon, manager, Raymond Pulverizer Division, Combustion Engineering Company, Inc., Chicago, Ill.

Heat Transfer Through Thick Insulation on Cylindrical Enclosures, by G. M. Dusinberre, professor, University of Delaware, Newark, Del., and T. S. Nickerson, E. I. du Pont de Nemours and Company, Belle, W. Va.

Industrial Instruments and Regulators (I)

Stability of SR-4 Electric Strain Gages in Ship Use, by A. Boodberg, E. D. Howe, professor, and B. York, University of California, Berkeley, Calif.

Development of an Air-Operated Force Measuring System, by A. A. Markson, mechanical engineer, Hagan Corporation, Pittsburgh, Pa., and Ray S. Williams, production engineer, Hagan Corporation, Orrville, Ohio.

Properties of Gases (I)—Applied Mechanics (II)—Heat Transfer (II)

The Present State of Our Knowledge of Gas Properties

Part I Vapor Pressure, Specific Volume, P-V-T Data for H_2, N_2, O_2, CO, CO_2, Air, He, A, and Hg, by Serge Gratch, instructor, University of Pennsylvania, Philadelphia, Pa.

Part II A Brief Review of the Available Data on the Dynamic Viscosity and Thermal Conductivity for Twelve Gases, by G. A. Hawkins, assistant dean, graduate school, Purdue University, Lafayette, Ind.

Part III Molecular Constants From Spectroscopic Data, by G. Herzberg, Yerkes Observatory of the University of Chicago, Williams Bay, Wis.

Part IV Joule-Thomson Coefficient, by H. L. Johnston, The Ohio State University, Columbus, Ohio

Part V Vapor Pressure, Specific Volume, and P-V-T Data for H_2O, CH_4, C_2H_4, and NH_3, by Frederick G. Keyes, professor, Massachusetts Institute of Technology, Cambridge, Mass.

Part VI Dielectric Constant and Refractivity Data, by John G. Miller, professor, University of Pennsylvania, Philadelphia, Pa.

Part VII Heats of Formation and Chemical Thermodynamic Properties, by Frederick D. Rossini, National Bureau of Standards, Washington, D. C.

12:15 p.m.

Keynote Luncheon

2:30 p.m.

Heat Transfer (III)

Papers to be announced.

Education (I)—Keynote Session

Speaker: To be announced

Applied Mechanics (III)

Solution of the Frequency Equation for the Generalized Lumped Constant Linear Mechanical System with Damping, by George K. Hess, Jr., instructor, University of Michigan, Ann Arbor, Mich.

Vibration of a Nonlinear System During Acceleration Through Resonance, by E. E. Weibel, professor, University of Colorado, Boulder, Colo., and R. B. Meuser, design engineer, University of California, Berkeley, Calif.

Aerodynamic Oscillations in Suspension Bridges, by E. Pinney, University of California, Berkeley, Calif.

The Permanent Strain in a Uniform Bar Due to Longitudinal Impact, by Merit P. White, scientific consultant, New York, N. Y., and LeVan Griffis, Illinois Institute of Technology, Chicago, Ill.

Buckling of Transverse Stiffened Plates Under Shear, by Tsun Kuei Wang, director, aeronautical engineering department, National Northwest University, Sian, Shensi, China (by title).

Industrial Instruments and Regulators (II)

Frequency Response Measurements of a Hydraulic Power Unit, by M. Russell Hannah, project engineer, Sperry Gyroscope Company, Incorporated, Great Neck, N. Y.

Continuous Determination of Oxygen Concentration Based on the Magnetic Properties of Gases, by Robert D. Richardson, research engineer, The Hays Corporation, Michigan City, Ind.

Electrical Systems for Aircraft Flowmeters, by R. G. Ballard, General Electric Company, West Lynn, Mass.

Properties of Gases (II)—Applied Mechanics (IV)—Heat Transfer (IV)

Industry's Requirements in Gas Properties Research, by Newman A. Hall, professor, Institute of Technology, University of Minnesota, Minneapolis, Minn.

Facilities for and Work Under Way in Gas Properties Research, by Robert V. Kleinschmidt, consulting engineer, Stoneham, Mass.

5:00 p.m.

Business Meeting

7:00 p.m.

General Dinner

8:30 p.m. and 9:30 p.m.

Motion Picture

The New America, a motion picture which attempts to appraise America's economy, its industrial capacity, and its spirit.

TUESDAY, DECEMBER 2

9:30 a.m.

Applied Mechanics (V)

Deflections and Moments of a Plate Clamped on all Edges and Under Hydrostatic Pressure, by Ezra G. Odley, principal design engineer, Bureau of Yards and Docks, Navy Department, Washington, D. C.

Effect of Bending Rigidity of Stringers Upon Stress Distribution in Reinforced Monocoque Cylinder Under Concentrated Transverse Loads, by Robert S. Levy, project stress analyst, Republic Aviation Corporation, Farmingdale, N. Y.

Effect of a Concentric Reinforcing Ring on Stiffness and Strength of a Circular Plate, by William A. Nash, assistant engineer, Armour Research Foundation, Illinois Institute of Technology, Chicago, Ill.

Note on Tightness of Expanded Tube Joints, by George Sachs, professor of physical metallurgy, Case Institute of Technology, Cleveland, Ohio

Heat Transfer (V)

Shell Side Heat Transfer Characteristics of Segmentally Baffled Shell-and-Tube Heat Exchangers, by Townsend Tinker, chief engineer, Ross Heater and Manufacturing Company, Buffalo, N. Y.

Panel Discussion on Heat Exchangers

Speakers: A. P. Colburn, professor, chemical engineering, University of Delaware, Newark, Del.; A. Y. Gunter, district manager, American Locomotive Company, New York, N. Y.; S. Kopp, assistant chief engineer, Alco Products Division, American Locomotive Company, New York, N. Y.; and B. E. Short, professor, mechanical engineering, University of Texas, Austin, Texas

Hydraulic (I)

Hydraulic Problems in Connection With the Design of the Granby Pumping Plant, by Eliot B. Moses, mechanical engineer, electrical division, hydraulic-equipment section.

THERE WILL BE GOOD GOLFING ON THE LINKS OF ATLANTIC CITY DURING THE A.S.M.E. 1947 ANNUAL MEETING

Bureau of Reclamation, U. S. Department of Interior, Denver, Colo.

Pumping Requirements for Irrigation on Columbia Basin and Central Valley Projects of the Bureau of Reclamation, by Irving L. Wightman, engineer, Bureau of Reclamation, U. S. Department of Interior, Denver, Colo.

Metals Engineering (I)—Railroad (I)

Construction and Maintenance of Railroad Equipment by Submerged and Gas-Shielded Electric Welding, by Norman G. Schreiner, manager, Unionmelt Service and Development, The Linde Air Products Company, New York, N. Y.

Notes on the Design and Construction of Staybolted Locomotive Fireboxes, by Fred P. Huston, charge of railroad development, development and research department, International Nickel Company, Inc., New York, N. Y.

Oil and Gas Power (I)

Problems Associated With the Use of Diesel Fuel Oil, by W. L. H. Doyle, assistant director of research, and E. W. Landen, Caterpillar Tractor Company, Peoria, Ill.

Removal of Aldehydes From Diesel Exhaust Gas, by Rogers F. Davis and M. A. Elliott, assistant division chief, U. S. Bureau of Mines, Pittsburgh, Pa.

Power (I)

An Experimental Determination of Sound in Superheated Steam by Ultrasonics, by James Woodburn, Johns Hopkins University, Baltimore, Md.

Production Engineering (I)

Man-Au-Trol, by E. P. Bullard, III, vice-president, charge of manufacture, The Bullard Company, Bridgeport, Conn.

Surface Broaching, by Oliver W. Bonna Fe, chief research engineer, The Lapointe Machine Tool Company, Hudson, Mass.

Materials Handling (I)

Handling Equipment at Railroad Terminals and Shops, by Daniel Polderman, vice-president, Whiting Corporation, New York, N. Y.

Materials Handling Methods and the Application of Incentive Compensation, by H. B. Shaw, staff engineer, Methods Engineering Council, Pittsburgh, Pa.

12:15 p.m.

Nuclear Energy General Luncheon

Speaker: David Lilienthal, chairman, Atomic Energy Commission, Washington, D. C.

Subject: Atomic Energy and the Engineer

2:30 p.m.

Fuels (I)

Symposium on Improving the Availability of Steam Motive Power

Regional Standards for Locomotive Fuels, by E. C. Payne, consulting engineer, Pittsburgh Consolidation Coal Company, Pittsburgh, Pa.

Locomotive Firebox and Boiler Performance, by F. D. Mosher, research engineer, Standard Stoker Company, Erie, Pa.

"Hydraulic Old-Timers" Annual Dinner

"TUESDAY is Hydraulics Day" is the slogan of the A.S.M.E. Hydraulic Division for the A.S.M.E. 1947 Annual Meeting.

The "Hydraulic Old-Timers" annual dinner will be held on Tuesday, Dec. 2, at 6:30 p.m.

So enthusiastic was the response to the dinner last year that it was voted then and there to make the dinner an annual event. Old-timers and friends of the Hydraulic Division are invited to attend. Invitations have been mailed to all who were present last year. If you plan to attend, please drop a note to Leslie J. Hooper, c/o Worcester Polytechnic Institute, Worcester, Mass., or to S. Logan Kerr, Bankers Securities Building, Philadelphia 7, Pa. Tickets, $5.75.

If you are a hydraulics man, come, come to the "Hydraulic Old-Timers" Annual Dinner.

Better Locomotive Servicing Facilities on the Norfolk and Western Railway, by C. E. Pond, assistant to superintendent, motive power, Norfolk and Western Railway, Roanoke, Va.

Intensive Utilization of Coal-Fired Steam Locomotives, by E. L. Johnson, assistant chief engineer, motive power and rolling stock, New York Central System, New York, N. Y.

Developments and Trends in Coal-Burning Locomotives, by Charles Kerr, Jr., consulting transportation engineer, Westinghouse Electric Corporation, East Pittsburgh, Pa.

Nuclear Energy—Power (II)

Nuclear Energy—Basic Design Background, by John R. Huffman, chief, process design, Clinton Laboratories, Oak Ridge, Tenn.

Applied Mechanics (VI)

Mechanical Activation—A Newly Developed Chemical Process, by M. C. Shaw, assistant professor, mechanical engineering, Massachusetts Institute of Technology, Cambridge, Mass.

Investigations of the Flow in Curved Ducts at Large Reynolds Numbers, by John R. Weske, Purdue University, Lafayette, Ind.

The Mechanics and Thermodynamics of Steady One-Dimensional Gas Flow, by A. H. Shapiro, associate professor, mechanical engineering, and William R. Hawthorne, associate professor, mechanical engineering, Massachusetts Institute of Technology, Cambridge, Mass.

Tensorial Analysis of Control Systems, by Gabriel Kron, consulting engineer, General Electric Company, Schenectady, N. Y.

Large Displacements With Small Strains in Loaded Structures, by Keith H. Swainger, Imperial College of Science and Technology, South Kensington, London, England (by title).

Gas Turbine Power (I)—Heat Transfer (VI)—Oil and Gas Power (II)

High-Performance Surfaces for Gas-Turbine Plant Regenerators, by A. L. London, associate professor, mechanical engineering, Stanford University, Stanford University, Calif., and C. K. Ferguson, teaching assistant, mechanical engineering, University of California, Berkeley, Calif.

A Design Method for Counterflow Shell-and-Tube Heat Exchanges for Gas Turbines, by D. G. Shepherd, chief experimental engineer, gas turbine engineering division, A. V. Roe Canada, Ltd., Malton, Ont., Can.

Panel Discussion on Heat Exchangers, by K. A. Gardner, engineer, The Griscom-Russell Company, New York, N. Y.

Hydraulic (II)

Laboratory Investigations of the Mechanism of Cavitation, by R. T. Knapp, director, hydrodynamics laboratory, and A. Hollander, associate professor, California Institute of Technology, Pasadena, Calif.

The Hydrodynamics Laboratory at California Institute of Technology, by R. T. Knapp, director, hydrodynamics laboratory, Joseph Levy, Barton Brown, and J. Pat O'Neill, all of California Institute of Technology, Pasadena, Calif.

Machine Design (I)—Production Engineering (II)

Panel on Design for Production

Speakers: George Landis, vice-president in charge of engineering, Lincoln Electric Company, Cleveland, Ohio; P. C. Smith, assistant to division manager, Westinghouse Electric Corporation, East Pittsburgh, Pa.; Lewis Clement, director of research and engineering, Crosley Division, AVCO Manufacturing Corporation, Cincinnati, Ohio; F. O. Hoagland, master mechanic, Pratt and Whitney Division, Niles-Bement-Pond Company, West Hartford, Conn.; C. Cuthbertson, department head in engineering, manu-

BRIGHT SKIES, OPEN SHOPS, AND CONVIVIAL CROWDS ARE A PART OF THE ATLANTIC CITY WINTER SCENE

facture organization, Western Electric Company, Inc., Haverhill, Mass.; A. F. Murray, works manager, Electrolux Corporation, Old Greenwich, Conn.

Materials Handling (II)

Economies in the Handling of Materials in Industry, by Harry E. Stocker, president, H. E. Stocker Associates, New York, N. Y.

Is It Right? Will It Work? Will It Pay? A unique graphic way of solving materials-handling problems, by Terry Carter, materials-handling engineer, American Cyanimid Company, New York, N. Y.

Education (II)

The Introduction of the Junior Engineer:

To His Society, by Alton C. Chick, assistant vice-president, engineer, Manufacturers Mutual Fire Insurance Company, Providence, R. I.

To His Job, by T. W. Prior, personnel division, Goodyear Rubber Company, Akron, Ohio

To His Community, by L. J. Fletcher, director of training and community relations, Caterpillar Tractor Company, Peoria, Ill.

6:30 p.m.

Fuels Dinner

Toastmaster: E. G. Bailey, president-elect, A.S.M.E., vice-president, Babcock and Wilcox Company, New York, N. Y.

Speaker: Fred S. McConnell, president, National Coal Association, Washington, D. C., and president, Enos Coal Mining Company, Cleveland, Ohio

Subject: The Coal Industry Looks Ahead

"Hydraulic Old-Timers" Annual Dinner

Organ Music

WEDNESDAY, DECEMBER 3

9:30 a.m.

Applied Mechanics (VII)

A Numerical Solution for the Torsion of Hollow Sections, by E. C. Colin and N. W. Newmark, research professor, department of civil engineering, University of Illinois, Urbana, Ill.

On the Use of Power Laws in Stress Analysis Beyond the Elastic Range, by Alice Winzer, research associate, and W. Prager, professor, applied mechanics, Brown University, Providence, R. I.

Approximate Solutions for Symmetrically Loaded Thick-Walled Cylinders, by C. W. MacGregor, professor, applied mechanics, and L. F. Coffin, Jr., assistant professor of mechanical engineering, Massachusetts Institute of Technology, Cambridge, Mass.

Stresses in a Notched Strip Under Tension, by Chih-Bing Ling, Guggenheim Aeronautical Laboratory, California Institute of Technology, Pasadena, Calif.

Registration Fee for Nonmembers

THERE will be a registration fee of $5 for nonmembers attending the 1947 Annual Meeting. The fee shall be the same for attendance at one or all sessions.

Guest-attendance cards issued formerly to members upon request have been discontinued.

Nonmember authors, immediate family of members, and nonmember students serving as aids will not be required to pay a registration fee.

WINTER VISITORS ENJOYING THE SEA BREEZES OF THE ATLANTIC

Fuels (II)—Gas Turbine Power (II)—Oil and Gas Power (III)—American Rocket Society (I)

Ignition of Flame Stabilization Processes in Gases, by Bernard Lewis, chief, explosives division, and Guenther von Elbe, both of U. S. Bureau of Mines, Bruceton, Pa.

High-Output Combustion of Ethyl Alcohol and Air, by A. H. Shapiro, associate professor, mechanical engineering, D. Rush, division of industrial co-operation, W. A. Reed, research associate, department of chemical engineering, D. G. Jordon, division of industrial co-operation, Massachusetts Institute of Technology, Cambridge, Mass., and G. Farnell, mechanical engineer, research department, Ingersoll-Rand Company, Phillipsburg, N. J.

The Influence of Reaction Interface Extension on the Combustion of Gaseous Fuel Constituents, by W. J. Wohlenberg, Sterling professor, mechanical engineering, Yale University, New Haven, Conn.

Heat Transfer (VII)

Condensation of Refrigerant Vapors—Apparatus and Film Coefficients for Freon-12, by R. E. White, York Corporation, York, Pa.

Condensation on Six Finned Tubes in a Vertical Row, by D. L. Katz, professor, chemical engineering, and J. M. Geist, University of Michigan, Ann Arbor, Mich.

Prediction of Pressure Drop During Forced-Circulation Boiling of Water, by R. C. Martinelli, general engineering and consulting laboratory, and D. B. Nelson, mechanical engineer, General Electric Company, Schenectady, N. Y.

Materials Handling (III)—Management (I)

Materials Handling in the Distribution Department of the Telephone Division of the Western Electric Company, by F. C. Podboy, director, staff developments and results division, distribution department, telephone division, Western Electric Company, Inc., New York, N. Y.

Management's Interest in the Application of Conveying Machinery, by E. J. Burnell, vice-president, Link-Belt Company, Chicago, Ill.

Metals Engineering (II)

Engineering for Aluminum Alloy Castings, by H. J. Rowe, chief metallurgist, castings division, and T. R. Gauthier, metallurgical department, Aluminum Company of America, Pittsburgh, Pa.

Magnesium Castings, Their Production and Use, by M. E. Brooks, chief metallurgist, and A. W. Winston, manager, quality control, Dow Chemical Company, Midland, Mich.

Production Engineering (III)

A Clinical Approach to Weldment Design, by Gerald Von Stroh, assistant manager, development engineering, Lukens Steel Company, Coatesville, Pa.

Production of All Welded Tractor Frame and Clutch Case, by Charles A. Davis, purchasing department engineer, Caterpillar Tractor Company, Peoria, Ill.

Railroad (II)

Report on Railway Mechanical Engineering, by T. F. Perkinson, manager, railroad rolling stock division, General Electric Company, Erie, Pa.

Forum: Locomotive Developments

Forum leader: C. E. Pond, assistant to superintendent, motive power, Norfolk and Western Railway, Roanoke, Va.

Speakers: John S. Newton, assistant manager, engineering, steam division, Westinghouse Electric Corporation, Philadelphia, Pa.; J. F. Griffin, chief engineer, Superheater Company, East Chicago, Ind.; C. D. Stewart, vice-president, Westinghouse Air Brake Company, Wilmerding, Pa.

The South African Railways from a Mechanical Engineer's Aspect, by M. M. Loubser, chief mechanical engineer, South African Railways, Pretoria, South Africa

Other speakers: John I. Yellott, director of research, Locomotive Development Committee, Baltimore, Md.; Walter Giger, steam turbine department, Allis-Chalmers Mfg. Co., Milwaukee, Wis.; A. J. Townsend, vice-president, Lima Locomotive Works, Inc., Lima, Ohio

The Turbine Locomotive and Tansmission Systems, by Rupen Eksergian, vice-president, research, The Edw. G. Budd Mfg. Co., Philadelphia, Pa.

Power (III)

The 2000-Psi, 1050 F and 1000 F Reheat Cycle at the Philip Sporn and Twin Branch Steam-Electric Stations, by Philip Sporn, executive vice-president, chief engineer, American Gas and Electric Service Corporation, New York, N. Y.

12:15 p.m.

Student Luncheon

2:00 p.m.

Railroad (III)

Continuation of Locomotive Developments Forum

Production Engineering (IV)

A Discussion of Modern Quality Control Techniques, by C. W. Kennedy, quality control engineer, Federal Products Corporation, Providence, R. I.

Practical Applications of Quality Control, by E. E. Folsom, engineer, quality activities, General Electric Company, Bridgeport, Conn.

Gas Turbine Power (III)—Fuels (III)—Oil and Gas Power (IV)—American Rocket Society (II)

Gas Turbine Plant Combustion Chamber Efficiency, by A. L. London, associate professor, department of mechanical engineering, Stanford University, Stanford University, Calif.

Temperature Measurements and Combustion Efficiency in Combustors for Gas-Turbine Engines, by Walter T. Olson, chief, combustion branch, Flight Propulsion Laboratory, and Everett Bernardo, head, rocket section, Aircraft Engine Research Laboratory, National Advisory Committee for Aeronautics, Cleveland, Ohio.

The Determination of Gas Turbine Combustion Chamber Efficiency by Chemical Means, by Peter Lloyd, Ministry of Supply, National Gas Turbine Establishment, Pyestock Cove, Farnsborough, Hants, England.

Heat Transfer (VIII)

To be announced.

Applied Mechanics (VIII)

The Flutter of a Uniform Wing With Tip Weights, by Martin Goland, chairman, engineering mechanics research, and Y. L. Luke, staff mathematician, Midwest Research Institute, Kansas City, Mo.

The Bending of Symmetrically Loaded Circular Plates of Variable Thickness, by H. D. Conway, Cornell University, Ithaca, N. Y.

The Basic Elastic Theory of Vessel Heads Under Internal Pressure, by G. W. Watts, engineering division, and W. R. Burrows, assistant chief engineer, Whiting Refinery, Standard Oil Company of Indiana, Whiting, Ind.

Large Deflections of Rectangular Plates, by H. A. Lang, Sibley College of Engineering, Cornell University, Ithaca, N. Y. (by title).

The Absolute Calibration of Electromechanical Pickups, by Horace M. Trent, head, shock and vibration, instrumentation, and field engineering section, sound division, Naval Research Laboratory, Navy Department, Washington, D. C.

Machine Design (II)

Dynamic Analysis of Cams, by J. A. Hrones, professor, Massachusetts Institute of Technology, Cambridge, Mass.

Curvature Acceleration Relations for Plane Cams, by M. L. Baxter, Jr., mechanical engineer, Gleason Works, Rochester, N. Y.

THERE WILL BE SPORT ON THE WIND-SWEPT BEACHES DURING THE A.S.M.E. 1947 ANNUAL MEETING

Management (II)

Social Aspects of Decentralization, by Don G. Mitchell, president, Sylvania Electric Products, Inc., New York, N. Y.

Royal Little, president, Textron, Inc., New York, N. Y., will speak on a management subject.

Materials Handling (IV)

Co-Ordinating Materials Handling Methods With the Production Cycle, by S. C. Hoey, director, headquarters manufacturing engineering department, Westinghouse Electric Corporation, East Pittsburgh, Pa.

Materials Handling in the Storeroom (speaker to be announced)

Metals Engineering (III)

Effect of Some Processing Variables on the Stresses Required to Draw Tubular Parts, by G. Sachs, professor, and G. Espey, field engineer, Case Institute of Technology, Cleveland, Ohio

Large Hydraulic Forging Presses, by M. D. Stone, manager, development department, and F. C. Biggert, chairman of board, charge of engineering, United Engineering and Foundry Company, Pittsburgh, Pa.

6:30 p.m.

Banquet

Speaker: E. W. O'Brien, president, A.S.M.E.

Subject: Accents on Youth

THURSDAY, DECEMBER 4

9:30 a.m.

Gas Turbine Power (IV)—Hydraulic (III)—Oil and Gas Power (V)—Aviation (I)

Analysis of Compressor Design, by A. J. Jadot, administrateur de la faculté, Polytechnique de Mons, Belgium

Axial Flow Compressors for Gas Turbines, by A. I. Ponomareff, manager, Westinghouse Electric Corporation, Philadelphia, Pa.

A Method of Correlating Axial Flow Compressor Cascade Data, by Hunt Davis, division engineer, Elliott Company, Jeannette, Pa.

Machine Design (III)

Development of a High-Speed Lathe for Machining Aluminum, by R. L. Templin, director of research, Aluminum Company of America, New Kensington, Pa.

Ball Bearing Slides, by C. Jobst, consulting engineer, Owens Brush Company, Toledo, Ohio

Electrification Increases Productivity of Small Turret Lathes, by Robert Clark, electrical engineer, Warner and Swasey Company, Cleveland, Ohio

Management (III)

Predesign Research as Applied to Product Development, by Roger L. Nowland, partner, Van Doren, Nowland & Schladermundt, New York, N. Y.

User Research as a Tool in Developing New Industrial Products, by Ernest E. Wachsmuth, James O. Peck Company, New York, N. Y.

Metals Engineering (IV)—Applied Mechanics (IX)

Strength and Failure Characteristics of Thin Circular Membranes, by G. Sachs, professor, and W. F. Brown, Jr., Case Institute of Technology, Cleveland, Ohio

Design of Machine Components by Full-Scale Fatigue Testing, by C. B. Griffin and A. F. Underwood, head, mechanical-engineering department, General Motors Corporation, Detroit, Mich.

Development of Cleavage Fractures in Mild Steels, by A. B. Bagsar, chief metallurgical engineer, Sun Oil Company, Philadelphia, Pa.

Railroad (IV)

Forum: Freight Car Construction

Forum leader: J. D. Loftis, chief, motive power and equipment, Atlantic Coast Line Railroad, Wilmington, N. C.

Speakers: A. F. Stuebing, assistant to manager of sales, Carnegie-Illinois Steel Company, Pittsburgh, Pa.; S. M. Felton, president, American Railway Car Institute, New York, N. Y.; E. A. Sipp, manager, Reynolds Metals Company, Inc., Chicago, Ill.; L. K. Sillcox, vice-president, New York Air Brake Company, Watertown, N. Y.; George A. Suckfield, consulting engineer, Pressed Steel Car Company, Pittsburgh, Pa.; G. B. Hauser, assistant chief engineer, railroad division, Aluminum Company of America, New Kensington, Pa.; M. S. Downes, assistant general manager, Railway Division, Timken Roller Bearing Company, Canton, Ohio; and R. B. Cottrell, chief mechanical engineer, American Steel Foundries, Chicago, Ill.

9:30 a.m.

Fuels (IV)

Furnaces for By-Product Fuels, by Otto de Lorenzi, director of education, Combustion Engineering Company, Inc., New York, N. Y.

Experimental Combustion of Pulverized Coal at Atmospheric and Elevated Pressures, by H. R. Hazard, research engineer, fuels division, Battelle Memorial Institute, Columbus, Ohio, and F. D. Buckley, engineer, Locomo-

tive Development Committee, Dunkirk, N. Y.

Safety

New Ideas in Accident Prevention

Integrating Safety Engineering in Engineering College Curricula, by H. W. Heinrich, assistant superintendent, engineering and inspection department, Travelers Insurance Company, Hartford, Conn.

Using Operations Analysis Procedures for Accident Prevention, by John V. Grimaldi, division of industrial service, National Conservation Bureau, New York, N. Y.

Personal Factors for Developing Safety Consciousness, by Walter A. Cutter, administrative assistant, Center of Safety Education, New York University, New York, N. Y.

12:00–1:00 p.m.

Jet Aircraft Demonstrations

Atlantic City Naval Air Station

Demonstration of rocket-assisted take-off, demonstration flights of A.A.F. and Naval jet-propelled aircraft and static-firing demonstration of liquid-fuel rocket engine.

12:15 p.m.

Society General Luncheon

Presentation of Gantt Medal for 1947

Toastmaster: John A. Willard, partner, Bigelow, Kent, Willard and Company, New York, N. Y.

Speaker: Eugene W. O'Brien, president, A.S.M.E., vice-president and director, W. R. C. Smith Publishing Company, Atlanta, Ga.

Gantt Medal Presentation: John M. Hancock, Lehman Bros., New York, N. Y., will sketch the background of the Gantt Medal Award and the reasons why Alvin E. Dodd was selected for the 1947 Award. Harold V. Coes, vice-president, Ford, Bacon and Davis, Inc., New York, N. Y., will present the Medal to Mr. Dodd.

Acceptance address: Alvin E. Dodd, president, American Management Association, New York, N. Y., will speak on "Productivity—Prices—Markets."

2:00 p.m.

Railroad (V)

Auspices of the Railroad Division

Continuation of Freight Car Construction Forum

2:30 p.m.

Management (IV)

Modern Quality Control, by S. Collier, director of quality control, Johns-Manville Corporation, New York, N. Y.

Some Engineering Aspects of Quality Control, by A. G. Dalton, superintendent, quality control, Western Electric Company, New York, N. Y.

Measurement of Opinion, Attitudes, and Consumer Wants, by F. F. Stephan, director of sampling studies, Committee on Measurement of Opinion, Attitudes, and Consumer Wants, Cornell University, Ithaca, N. Y.

Process Industries

Why Pollution Abatement Concerns the Mechanical Engineer, by J. R. Hoffert, assistant chief engineer, department of health, Commonwealth of Pennsylvania, Harrisburg, Pa.

Waste Disposal Problems From Oil Refineries, by W. B. Hart, charge of waste disposal, Atlantic Refining Company, Philadelphia, Pa.

2:30 p.m.

Heating Values of Fuels

Symposium on Heat Values of Fuels for Thermal Efficiency and Power-Cycle Analyses

Current Definitions of High- and Low-Heat Values of a Fuel and Current Methods for Their Determination, by E. F. Fiock, physicist, National Bureau of Standards, Washington, D. C.

Current Definitions of Thermal Efficiencies and Current Usage of Observed Fuel Heat Values and Consumption Test Data for the Evaluation of Thermal Efficiencies Reported for (*a*) Steam, (*b*) Reciprocating Internal-Combustion Engine, and (*c*) Combustion Gas Turbine Power Plants, by A. G. Christie, professor, school of engineering, Johns Hopkins University, Baltimore, Md.

Discussion of Procedures for Evaluating Energy, Temperature, and Pressure Relations Based on Later-Day Knowledge of Thermodynamic Properties of the Gases Resulting From the Combustion of Fuel in These Thermal Devices, by R. V. Kleinschmidt, consulting engineer, Stoneham, Mass.

Fuels (V)

Mechanisms of Combustion and Their Relation to Oil-Burner Design, by Harold R. Heiple, senior fuel-oil research engineer, and William A. Sullivan, senior fuel-oil application engineer, Shell Oil Company, Inc., New York, N. Y.

Synthetic Liquid Fuels in the United States, by W. C. Schroeder, chief, Office of Synthetic Liquid Fuels, Bureau of Mines, Washington, D. C.

Fluid Meters

Analysis of Positive-Displacement Meters, for Liquid Hydrocarbons, by E. E. Ambrosius, professor, mechanical engineering, Pennsylvania State College, State College, Pa.

High-Pressure Gas Measurements, by E. E. Stovall, superintendent of measurement, Lone Star Gas Company, Dallas, Texas

Oscillating Piston Meters for Fuel Consumption in Aircraft, by Charles S. Hazard, director of research, Neptune Meter Company, New York, N. Y.

Oil and Gas Power (VI)—Gas Turbine Power (V)

Discussion of Transmission Systems for Marine Propulsion of Gas Turbine Power Plants, by W. E. Hammond, chief, engineering scientific and electric section, U. S. Maritime Commission, Washington, D. C.

The Universal Optimum Power Cycle for Elastic Fluid Turbine Power Plants, by Frederick Nettel, consulting engineer, Manhasset, N. Y., and John Kreitner, technical director, American Hydromath Company, New York, N. Y.

Rubber and Plastics (I)

Papers to be announced.

6:30 p.m.

American Rocket Society Dinner

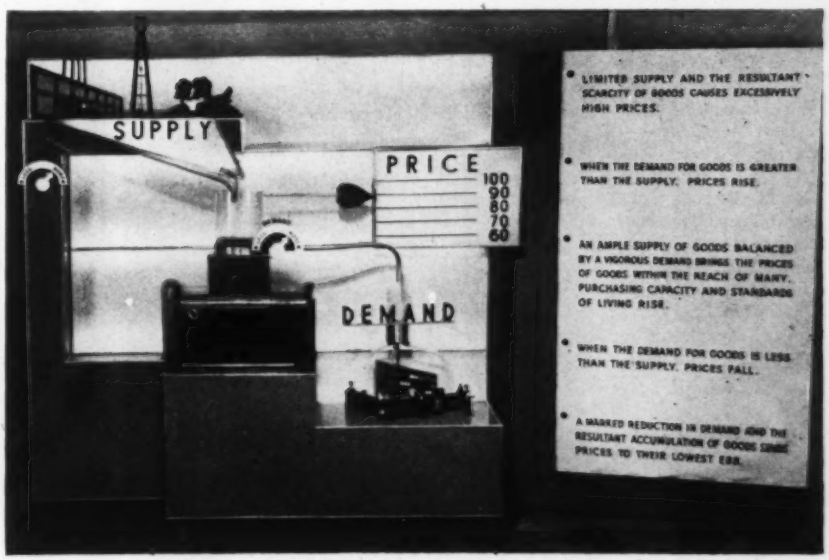
To be announced.

8:15 p.m.

Management (V)

Meritorious Achievements in the Field of Distribution and Practical Application of Improved Techniques

Trade Analysis as a Basis for Sales Engineering, by Luther D. Reed, director of trade analysis division, E. I. du Pont de Nemours and Company, Inc., Wilmington, Del.


SUPPLY
PRICE
100
90
80
70
60
DEMAND
LIMITED SUPPLY AND THE RESULTANT SCARCITY OF GOODS CAUSES EXCESSIVELY HIGH PRICES.
WHEN THE DEMAND FOR GOODS IS GREATER THAN THE SUPPLY, PRICES RISE.
AN AMPLE SUPPLY OF GOODS BALANCED BY A VIGOROUS DEMAND BRINGS THE PRICES OF GOODS WITHIN THE REACH OF MANY. PURCHASING CAPACITY AND STANDARDS OF LIVING RISE.
WHEN THE DEMAND FOR GOODS IS LESS THAN THE SUPPLY, PRICES FALL.
A MARKED REDUCTION IN DEMAND AND THE RESULTANT ACCUMULATION OF GOODS SENDS PRICES TO THEIR LOWEST EBB.

ONE OF THE JAMES D. MOONEY ECONOMIC EXHIBITS. THIS ONE DEMONSTRATES THE LAW OF SUPPLY AND DEMAND

Scientific Method of Distribution Applied to Retail Trade, by Earl R. French, The Great Atlantic and Pacific Tea Company, New York, N. Y.

Progressive Method of Distribution Applied to Petroleum Products, by O. F. Minor, Shell Oil Company, Inc., New York, N. Y.

8:15 p.m.

Power (IV) Marine Night

Technical and Economic Aspects of Water Purification, by R. V. Kleinschmidt, consulting engineer, Stoneham, Mass.

Low-Pressure Steam-Heated Distilling Plants, by A. M. Impagliazzo, engineer, and R. M. Bent, sales engineer, Griscom-Russell Company, New York, N. Y.

Oil Elimination From Feedwater, by M. Bradt, chief field engineer, Skinner Engine Company, Erie, Pa.

Demineralization Processes, by D. J. Saunders, vice-president, Permutit Company, New York, N. Y.

Rubber and Plastics (II)

Papers to be announced

Aviation (II)

A Gas-Turbine Development Laboratory at Westinghouse Electric Corporation, by W. R. New, manager, aviation-gas-turbine laboratory, Westinghouse Electric Corporation, Philadelphia, Pa.

An Aircraft Gas Turbine for Propeller Drive, by A. Howard, section engineer, gas turbine section, and C. J. Walker, development engineer, General Electric Company, Schenectady, N. Y.

8:15 p.m.

Applied Mechanics (X)—Heat Transfer (IX)—Properties of Gases (III)

A Report on the Properties of Certain Gases at the Georgia School of Technology, by R. L. Sweigert, dean, graduate division, Georgia School of Technology, Atlanta, Ga.

Generalized Thermodynamics of High Temperature Combustion, by H. C. Hottel, G. C. Williams, and C. N. Satterfield, department of chemical engineering, Massachusetts Institute of Technology, Cambridge, Mass.

Wartime Work of National Advisory Committee for Aeronautics on Thermodynamics, by L. R. Turner, flight propulsion research laboratory, The National Advisory Committee for Aeronautics, Cleveland, Ohio.

Thermodynamic Properties of Gas Mixtures Encountered in Gas-Turbine and Jet-Propulsion Processes, by J. Kaye, assistant professor, department of mechanical engineering, Massachusetts Institute of Technology, Cambridge, Mass.

FRIDAY, DECEMBER 5

9:30 a.m.

American Rocket Society (III)—Gas Turbine Power (VI)—Aviation (III)

Pumps and Turbines for Rocket Engines, by Wm. P. Munger, Reaction Motors, Inc., Dover, N. J.

The Story of Project 3401—The Pioneer Rocket of the U. S. Navy, by Lieut. Comdr. R. C. Traux, Bureau of Aeronautics, U. S. Navy Department, Washington, D. C.

Management (VI)

Joint Training in Labor Relations as Conducted by Botany Mills, Inc., and Textile Workers Union (C.I.O.), by Irving J. Phillipson, Major General U. S. A., retired, director of industry relations, Botany Mills, Inc., Passaic, N. J.

Implications for Executives in the 1947 Labor Management Relations Act, by John R. Bangs, Jr., general manager of industrial and personnel relations, and James W. Townsend, personnel manager, The Budd Company, Philadelphia, Pa.

Petroleum (I)

Lubricant Tests and Their Application to Engineering, by D. A. Hall and W. T. Everitt, engineers, Eastman Kodak Company, Rochester, N. Y.

Lubrication (I)

An Analysis of the Full-Floating Journal Bearing, by M. C. Shaw, assistant professor, mechanical engineering, Massachusetts Institute of Technology, Cambridge, Mass., and T. J. Nussdorfer, Jr., mechanical engineer, flight propulsion research laboratory, National Advisory Committee for Aeronautics, Cleveland, Ohio

Oil Flows and Temperature Relations in Lightly Loaded Journal Bearing, by John Boyd, section engineer, and B. P. Robertson, Westinghouse Research Laboratories, East Pittsburgh, Pa.

Measurements of the Combined Frictional and Thermal Behavior in Journal Bearing Lubrication, by S. A. McKee, H. S. White, and J. F. Swindells, National Bureau of Standards, Washington, D. C.

Citizenship

Round Table Discussion: Stimulating The Engineer's Participation as a Citizen

Wood Industries (I)

Integrated Forest Utilization in the Pacific Northwest, by O. H. Schrader, Jr., associate professor of forest products, College of Forestry, University of Washington, Seattle, Wash.

Laminating for Small-Boat Construction, by Donald F. May, Puget Sound Naval Shipyard, Bremerton, Wash.

Performance Characteristics of Tight White-Oak Laminated-Stave and Solid-Stave Barrels, by R. S. Kurtenacker, engineer, Forest Products Laboratory, Madison, Wis., and D. L. Patrick, General Plywood Corporation, Louisville, Ky.

12:15 p.m.

American Rocket Society Luncheon

2:30 p.m.

Petroleum (II)

Recommended Practices for the Preparation of New Turbine-Lubricating Systems, by F. E. Rosenstiehl, assistant manager, technical and research division, The Texas Company, New York, N. Y.

Asphalt in the Building Industry, by R. Brown, research engineer, Tilo Roofing Company, Inc., Stratford, Conn.

Effect of Temperature on Metals

Papers to be announced.

Lubrication (II)

Studies in Boundary Lubrication (II)—The Influence of Adsorbed Moisture Films on the Coefficient of Static Friction Between Lubricated Surfaces, by W. E. Campbell and E. A. Thurber, members of technical staff, Bell Telephone Laboratories, Murray Hill, N. J.

High-Temperature Performance of Silicone Fluids in Journal Bearings, by J. E. Brophy, mechanical engineer, J. Larson, research assistant, Naval Research Laboratory, Washington, D. C., and R. O. Militz, mechanical engineer, R. T. French Company, Rochester, N. Y.

The Hydrosphere—A New Hydrodynamic Bearing, by M. C. Shaw, assistant professor, mechanical engineering, and Charles D. Strang, Jr., research associate, mechanical engineering, Massachusetts Institute of Technology, Cambridge, Mass. (Sponsored jointly with the Applied Mechanics Division.)

American Rocket Society (IV)—Gas Turbine Power (VII)

Supersonic Research Aircraft, by Col. P. B. Klein, Army Air Forces, chief, fi[illegible] branch aircraft projects section, engin[illegible]ing division, Air Materiel Command, Wright Field, Dayton, Ohio

Liquid Rocket Motor Testing, by Robertson Youngquist, special research engineer, Glenn L. Martin Company, Baltimore, Md.

Thermochemistry of Rocket Propellants, by George P. Sutton, research engineer, Aerophysics Laboratory, North American Aviation, Inc., Inglewood, Calif.

Wood Industries (II)

Use of Wetting Agents in Forest Fire Control, by Hugh N. McNair, Union Carbide and Carbon Company, New York, N. Y.

Factory Layout and Equipment for the Mass Production of Molded Plywood Furniture, by E. Sigurd Johnson, consulting engineer, Salem, Va.

Frequency Heating in the Woodworking Industry, by Francis L. Macaluso, Westinghouse Electric Corporation, Baltimore, Md.

Results of Accelerated Tests and Long-Term Exposures on Glue Joints in Laminated Beams, by T. R. Truax and M. L. Selbo, Forest Products Laboratory, Madison, Wis.

Aviation (IV)

Foods on the Airlines, by H. H. Darby, former editor-in-chief, *Better Food*, Whitney Publications, Inc., New York, N. Y.

6:30 p.m.

Wood Industries Dinner

Presiding: C. B. Lundstrom, owner, Lundstrom Laboratories, Inc., Little Falls, N. Y.

Speaker: P. H. Bilhuber, vice-president, Steinway and Sons, Inc., New York, N. Y.

Subject: High-Frequency Molding of Compound Curvatures in Wood.

Individual Enterprise and Natural Wealth of West Discussed at A.S.M.E. Fall 1947 Meeting at Salt Lake City

SALT LAKE CITY was the locale of the 1947 Fall Meeting, of The American Society of Mechanical Engineers held September 1 to 4, 1947, as an important feature of Utah's centennial celebration commemorating the arrival of the first group of Mormon pioneers to the Great Salt Lake Valley. Speakers thus were provided the opportunity not only to recall the God-inspired fortitude and vision which characterized the early settlers of this area, but also to emphasize the need for such personal attributes throughout today's world. Such was the convention's underlying theme which constituted the unusual integration of local history and traditions with an exceptionally well-prepared engineering program. Consequently, this properly may be recorded as one of the most unique and valued meetings of our Society.

President O'Brien Speaks at Luncheon

At the opening luncheon on Monday, members and guests were welcomed by Salt Lake's Mayor Earl J. Glade and also by the Honorable Herbert B. Maw, Governor of Utah. Both officials paid tribute to the engineering profession and stressed the importance of the engineer to the greater industrial development of Utah and the West.

The principal speaker was Eugene W. O'Brien, president A.S.M.E., speaking on the subject "This Is the Place." His thesis was that Utah and the West "with its great undeveloped natural resources will lead industrial and other economic gains in this postwar period." He praised the Utah pioneers and asserted that "application of the industry, sacrifice, and diligence shown by these people would bring another era of unparalleled prosperity to the West." He added that there was a great contrast between pioneer and modern-day thinking, for "the modern tendency is to say that we have won another war, attained the promised land, and that everything will be milk and honey from now on. We do not appreciate that we have to work as of yore."

The witticism of the presiding officer, J. Calvin Brown, vice-president, A.S.M.E. Region VII, and the interesting introductions made by toastmaster A. Ray Olpin, president of the University of Utah, served to enhance the enjoyment of the session.

Intelligent Air Policy Needed

At the dinner on Monday evening, Douglas A. Elkins, junior A.S.M.E. and mechanical engineer of the Bureau of Mines, presided, with Blair L. Sackett, metallurgical manager of the International Smelting and Refining Company, acting as toastmaster.

Claude N. Monson, vice-president and general manager of Northrop Aircraft, Inc., Hawthorne, Calif., delivered the address. His subject was "The Present and Future of the Aircraft Industry."

Mr. Monson pleaded for continuation of a forceful intelligent air policy which would permit aircraft companies to carry on necessary development programs. He called attention to the fact that all the airplanes used in World War II were models developed before December 8, 1941. Aircraft development requires time and money. Its costs will be reflected in lives lost and damage done while America waits for planes not yet built, he said.

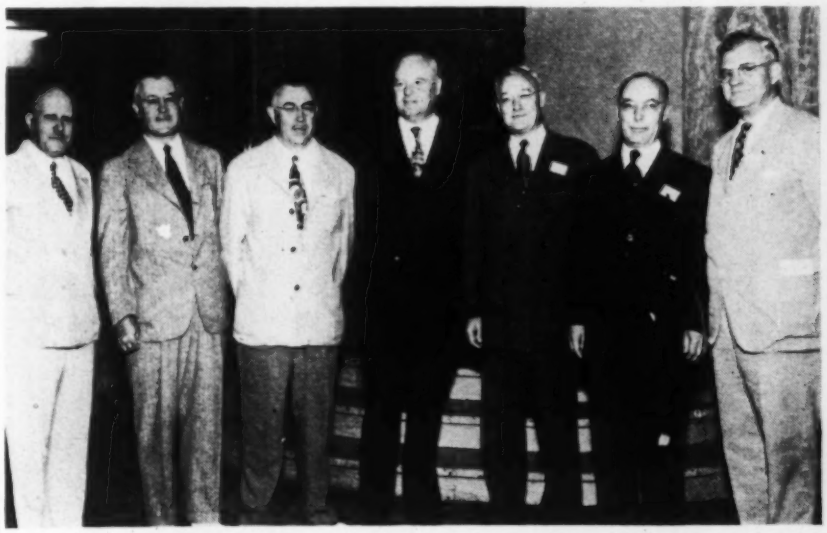
Engineers Must Be Citizens

Presiding at the Tuesday Luncheon was Jules D. Roberts, member A.S.M.E., vice-president, Mountain Fuel Supply Company of Salt Lake City. His toastmaster was Henry Eyring, dean, Graduate School, University of Utah. The subject of this meeting was education. Facts, figures, and fundamentals were presented by a man who has devoted his life to the subject "Basic Preparation Demanded by Industry of the Mechanical Engineer." The speaker was genial M. M. Boring, member A.S.M.E., staff assistant to vice-president, charge of engineering, General Electric Company. He advocated a closer integration of engineering schools and curricula with the needs of industry, and urged more thorough preparation in fundamentals, explaining that specialization is given by employers. With reference to "fundamentals," Mr. Boring recommended a thorough re-examination of the term and its meaning, clearly asking that basic cultural courses be included in the prescribed college program, since "engineers also must be citizens."

He disclosed that this year General Electric Company is spending $1,303,000, exclusive of salaries, for the training of 17,000 young graduate engineers. This program is justified, he said, because "only by such methods can we hope to meet the production problems ahead and to develop the needed applications to civilian life called for in the immediate future."

Joint Meeting With A.I.M.E.

Tuesday evening's banquet was held jointly with the Utah Section of the American Institute of Mining and Metallurgical Engineers. Presiding was W. H. H. Crammer, president and general manager, New Park Mining Company, Keetley, Utah. Carl J. Christensen, dean, School of Mines and Mineral Industries, University of Utah, acted as toastmaster. In introducing the evening's speaker, Dean Christensen referred to the value of joint meetings of the Founder Societies and explained that oftentimes, their fields of interests are common. Such was the case upon this



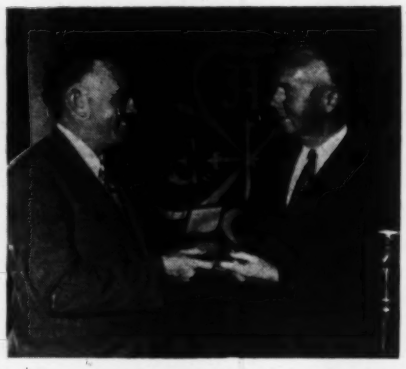
AT THE OPENING LUNCHEON ON MONDAY

(*Left to right:* Hon. Earl J. Glade, Mayor of Salt Lake City; A. Ray Olpin, president, University of Utah; Eugene W. O'Brien, president, A.S.M.E.; Hon. Herbert B. Maw, Governor of Utah; Clyde E. Williams, president, A.I.M.E., J. Calvin Brown, vice-president, A.S.M.E. Region VII; and C. E. Davies, secretary, A.S.M.E.)

occasion, when Clyde E. Willians, member A.S.M.E., president, A.I.M.E. and director of Battelle Memorial Institute, spoke on the subject of "Material and Power." Mr. Williams made special reference to a war-developed group of cobalt-titanium alloys and various metal oxides soon to be available for high-temperature and pressure service in turbojet propelled airplanes, rockets, and atomic-energy power plants. He said that these materials will offer potentialities for power generation that are "simply staggering. The gas turbine has met with so much success in aircraft, and the opportunity for securing metals to withstand high temperatures for long periods of time is so promising that this means of power generation will be extended to numerous other fields. Three gas turbines for ship propulsion are under construction for the navy and the maritime commission. Stationary power-generation units run by gas turbines of 5000 to 10,000 horsepower are in the planning stage. The gas turbine may be expected to compete with the Diesel in railway transportation since it offers similar advantages. A group of railway and coal companies is sponsoring the development of locomotives powered by gas turbines that will use coal instead of oil as fuel. Engineers are studying the possibility of utilizing small gas turbines in place of the larger piston engines for trucks and buses."

Utah's Early History Exemplified

The luncheon on Wednesday was concerned specifically with the early history of the Mormon pioneers as related by George Albert Smith, president, Church of Jesus Christ of Latter-Day Saints, and also by Richard L. Evans who is known nationally for his commentaries on the radio program "From the Crossroads of the West." The meeting was held jointly with the organization known as the Sons of the Utah Pioneers and was conducted by its president, George C. Lloyd.



PRESIDENT O'BRIEN (*left*) PRESENTING THE SPIRIT OF ST. LOUIS MEDAL TO JOHN K. NORTHROP (*right*) PRESIDENT, NORTHROP AIRCRAFT, INC., HAWTHORNE, CALIFORNIA, AT THE BANQUET WEDNESDAY EVENING

"This Is the Place, This Is the Time" was a masterfully presented and scholarly analysis of modern times by O. Meredith Wilson, dean, School of Arts and Sciences, University of Utah. A digest of his paper appears below:

On July 24, 1847, Brigham Young, from the box of his covered wagon, looked out from the mouth of Emigration Canyon over the Salt Lake Valley and told his companions, 'This is the Place.' This wasn't the beginning, but one of the climactic scenes in a dramatic pioneer project. Generally, historians have lumped the Mormon conquest of the Wasatch oasis with the general western movement in United States history. Frederick Jackson Turner who is, perhaps, the greatest of the western historians, made current the thesis that when the European reached the frontier, the environment was too strong for him. European civilization was reduced to savagery or barbarism and the frontiersman had to build back through the many cycles of history to re-establish a culture of his own. This new culture was, for Turner, no longer a European culture, but a new thing which we call American. I would not like to minimize the significance of the Turner proposition.

From the first founding of Utah, there was always a conscious feeling that the level of culture must not be permitted to drop in consequence of the privations of a frontier experiment. Schools were established for the children the first year of arrival. A university was chartered the third year after the Mormons had reached the valley. A community entertainment house called Social Hall was built almost at once, and within fourteen years after the founding of Salt Lake City, the huge Salt Lake Theatre was ready for the first players. Though the people were still scratching for food, they showed a hunger for the theater, for music, and art, and a determination to have as much of each as was possible. The consequence was that in Utah environment did not wholly conquer the settlers.

It is generally agreed that establishing farms and cities in the Great Basin was itself a difficult struggle. Yet, the determined Mormon pioneers would not be satisfied with mere physical conquest of the region if they must pay too high a price in cultural sacrifice. They demonstrated the ability of man, when moved by principle, to master nature.

John K. Northrop Honored

The Banquet took place Wednesday evening with President O'Brien presiding, and Linn Helander, vice-president, A.S.M.E. Region VIII, acting as toastmaster.

The Spirit of St. Louis Medal, highest aviation honor conferred by the A.S.M.E., was presented to John K. Northrop, president of Northrop Aircraft, Inc., Hawthorne, Calif. President O'Brien made the award in recognition of Mr. Northrop's vision and originality in the development of the "Flying Wing" and other contributions to aeronautical science. In accepting the award Mr. Northrop said that he hoped he could do it not as an individual, but perhaps as the quarterback who has planned a few plays and called a few signals for what he believed to be the finest team of competent engineers in the aviation world—the 750 men and women of the engineering department of Northrop Aircraft. Without them, he said, there would have been no accomplishment and no Spirit of St. Louis Award. He said he was accepting the award for the whole team and thanked the Society in the name of the many hundreds whose contributions to the advancement of aviation were being honored.

The principal speaker was Robert Sibley, Fellow A.S.M.E., and executive manager, Alumni Association, University of California. His discussion of "Atomic Energy, Its Uses and Abuses" was made simple to understand by reference to two golf balls representing atoms and also to the first cyclotron used by Dr. Lawrence of split salt atoms. Dr. Sibley reminded the audience that society now is living in year three of the Atomic Age and that its impact will have a marked influence upon the lives of each and every person. "When the two great bombs were dropped on Hiroshima and Nagasaki, man entered a new

AT JOINT MEETING WITH A.I.M.E., TUESDAY EVENING DINNER

(*Front row, left to right:* Mrs. James R. Long; Mrs. W. H. H. Cranmer; Mrs. Eugene W. O'Brien; Mrs. Carl J. Christensen; Mrs. Robert Sibley. *Back row, left to right:* James R. Long, metallurgist, U. S. Bureau of Mines, Salt Lake City, Utah; W. H. H. Cranmer, president, New Park Mining Company, Keetley, Utah; Clyde E. Williams, president, A.I.M.E.; Eugene W. O'Brien, president, A.S.M.E.; and Carl J. Christensen, dean, State School of Mines and Mineral Industries, University of Utah, Salt Lake City, Utah.)

era as wonderful and unexplored as was the age that received fire from heaven as recounted by the Greeks in the mythical story of Prometheus," he declared.

After presenting a review of Dr. Lawrence's early work at the University of California with his first cyclotron, Dr. Sibley urged that every effort be made to adopt the discovery to the benefit rather than to the elimination of our earthly existence. His opinion is that "all nations, including Russia, must come under a plan for full and complete harmonization of effort to control atomic energy for the good of mankind." Among new uses for products of atomic fission are the location of fossil remains in limestone deposits without the need for extensive and costly exploratory work, and the study of certain aspects of body chemistry which heretofore has been impossible.

West Has Industrial Potentialities

The final luncheon was held on Thursday with the Salt Lake Kiwanis Club. J. V. Glade, president of the Club, acted as the presiding officer. Introductions were made by S. L. Crawshaw, member A.S.M.E., and manager of engineering and sales, Western Gear Works at Seattle, Wash.

The paper "A Westerner Looks West" was much more than a factual account of the West's great potentialities for future industrial growth. It also was a pointed denunciation of those who would overthrow our prized democracy because "a few simple nuts in our economic machinery would not stay put." The individual speaking was Thomas J. Bannan, president of Webster-Brinkley Company, Hallidie Machinery Company, and Western Gear Works, all of Seattle, Washington. He advocated the widespread teaching of "the doctrine of basic Americanism. Talk to your associates, to your employees, to your friends—yes, and most important, to educators, and your wife and children. Tell them that work is honorable and profit is desirable. Explain that without incentive, work becomes slavery."

In conclusion, Mr. Bannan expressed his faith in the possibilities of the West by saying, "You may think I am enthusiastic about the future of the West. You are right. I am—with qualifications. I know that circumstances beyond the control of man or occurrences that spring from the very nature of man might create chaos. But I think we can stand on the theme proposed as the outset of our discussion which makes its own qualifications. We said that the American system of individual enterprise has been in fact successful, and if we retain it we should be able to keep our country great and enjoy the fruits of the potentialities which exist in the West. Nothing I can find makes me think that opportunity no longer exists in the West or in the nation, for that matter, except, perhaps, that there are those who thoughtlessly or maliciously would have us abandon the vehicle that has brought us where we are, abandon it for one which is far behind and, as far as I know, has never yet operated successfully."

Rail Sections Studied

The technical sessions opened on Monday with a series of three papers on metals engineering all of which were accompanied by interesting slides. The first was entitled "Research Work on Rail Sections," by Walter B. Leaf, research technician, Denver and Rio Grande Western Railroad, Denver, Colo. Mr. Leaf presented an absorbing paper describing the investigations made as the result of an actual failure of a 112-pound rail in his company's main line track near Green River, Utah. He presented a detailed description of how this problem of design was first attacked by the use of a program of photoelastic investigation, and later on by means of strain-gage measurements to determine the actual stress distribution in a rail. These investigations resulted in the adoption of a new 114-pound rail section in 1946 by the Denver and Rio Grande Western Railroad. No trouble has been experienced by the company since this new rail design was adopted.

PRESIDENT O'BRIEN POSES WITH THE FIRST CYCLOTRON

(*Left to right:* Mervin B. Hogan, professor of mechanical engineering, University of Utah; John K. Northrop, president, Northrop Aircraft, Inc., Hawthorne, Calif.; Eugene W. O'Brien, president A.S.M.E.; Robert Sibley, executive manager, Alumni Association, University of California; J. Calvin Brown, vice-president, A.S.M.E. Region VII.)

Kenneth A. DeLonge of the development and research division, International Nickel Company, under the title "Abrasion Resistance of Alloy White Cast Iron," described the improvement in the engineering properties and service performance of white cast iron when suitably alloyed to change the matrix structure from the usual pearlite to hard martensite. The increase in service life of such an alloy was usually in the order of two to three times.

This alloy was made by the addition of a nominal four and one half per cent nickel and two per cent chromium to white cast iron. Besides changing the matrix structure this addition also refines and hardens the carbides, producing a composite structure with outstanding abrasion resistance. These properties are further improved by chill casting. The excellent abrasion resistance of martensitic white iron minimizes metal-wear loss in the grinding, working, and conveying of abrasive materials as brought out in Mr. DeLonge's discussion.

S. A. Sulentic, consulting engineer of Topeka, Kan., delivered an informal talk before the group about the new engineering-license statute as passed by the recent Kansas legislature, which prohibits practice of all non-licensed engineers within the state.

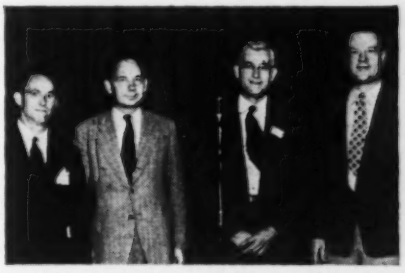
Type 405 Stainless Iron

The next paper was delivered by M. A. Schiel, director, metallurgical research, A. O. Smith Corporation, Milwaukee, Wis., on the subject, "A Stainless Iron for Lining Petroleum Refinery Vessels." This paper included a description of the excellent properties of modified type 405 stainless iron when used as a lining for petroleum-refinery vessels. According to Mr. Schiel, this metal was first introduced in 1938 and has since been used in hundreds of refinery vessels with only six known cases of embrittlement after long exposure to high temperatures, and not one single hardened brittle lining has been produced when the analysis has been within the proper specification. Modified type 405 stainless iron contains 13 per cent maximum chromium, 0.08 per cent maximum carbon, 0.20 to 0.30 per cent aluminum, and 0.02 per cent maximum titanium or columbium.

Training for Leadership

"Developing Leadership in Technically Trained and Experienced Engineers" was the topic of the technical session held on the afternoon of the opening day. The session was arranged under the auspices of the education committee and featured four speakers from western industrial concerns. M. M. Boring, member of the education committee of the A.S.M.E., acted as chairman and directed the group discussion. The following authorities were speakers on the panel: E. A. West, vice-president and general manager, Denver and Rio Grande Western Railroad Company, Denver, Colo; H. E. Callahan, supervisor of personnel, Hanford Engineering Works, General Electric Company, Richland, Wash.; R. C. Talbott, plant engineer, Geneva Steel Company, Geneva, Utah; and B. L. Wells, B. L. Wells Company, Los Angeles, Calif.

Although the training programs of the four concerns represented varied somewhat, all sought to bring out certain qualities in the trainees. Leadership was the requirement most stressed by all the speakers. The need of understanding the companies' policies, possessing the ability, developing the proper



AT EDUCATION LUNCHEON TUESDAY

(*Left to right:* Jules D. Roberts, member A.S.M.E., vice-president, Mountain Fuel Supply Company, Salt Lake City, Utah; Henry Eyring, dean, Graduate School, University of Utah, Salt Lake City, Utah; M. M. Boring, member A.S.M.E., staff assistant to vice-president, charge of engineering, General Electric Company, Schenectady, N. Y.; and Carl J. Christensen, dean, State School of Mines and Mineral Industries, University of Utah, Salt Lake City, Utah.)

SOME OF THOSE WHO TOOK PART IN THE EDUCATION SESSION MONDAY AFTERNOON

(*Left to right:* Carl J. Christensen, dean, State School of Mines and Mineral Industries, University of Utah; A. LeRoy Taylor, dean, State School of Engineering, University of Utah; M. M. Boring, member A.S.M.E., staff assistant to vice-president, charge of engineering, General Electric Company; Howard J. Hassell, member A.S.M.E., chief engineer, Power Engineering Company, Salt Lake City, Utah; R. C. Talbott, plant engineer, Geneva Steel Company, Geneva, Utah; B. L. Wells, B. L. Wells Company, Los Angeles, Calif.; E. A. West, vice-president, Denver and Rio Grande Western Railroad Company, Denver, Colo.; and H. E. Callahan, supervisor of personnel, Hanford Engineering Works, General Electric Company, Richland, Wash.)

attitude, and maintaining high personal standards were a few of the other requirements discussed. Mr. West explained the training program and methods used in selecting engineering personnel for supervisory and administrative positions. Mr. Callahan discussed his company's method of installing leadership qualities in engineers through their training program. He stressed the importance of engineers understanding management and human relations. Mr. Talbott described as necessary leadership qualities: the ability to cooperate; a broad knowledge of responsibilities of every department; loyalty; moral stability; and willingness to work. Mr. Wells remarked that a sweeping change is being made in management. This, in part, is due to the fact that workers will not accept the leadership that sufficed 20 to 30 years ago. Several charts were shown which illustrated the fact that employee problems must be treated as individual cases.

Application of Lighting Techniques

Monday evening a lively discussion of management problems was held when Harry T. Schwan, manager, Midwestern division, Methods Engineering Council, Kansas City, Mo., and Walter Sturrock, illuminating engineer, General Electric Company, Nela Park, Cleveland, Ohio, gave their papers. Mr. Schwan discussed in detail factors contributing to successful and economic management. These topics were presented to the audience tabulated on charts and considered one after the other by the speaker. They were emphasized as items of common sense and good judgment largely. Such features as studying necessary hand motions of workers, handling of material for most economic flow, and utilization of gravity as motivating force to accomplish such flow of materials are illustrations of the speaker's theme.

Mr. Sturrock advised that because of fluorescent lighting industry needs sound advice and wise planning as never before from engineers and designers. Lighting techniques are changing rapidly; new light sources are being used; the list of available equipment grows almost daily; and business will have to improve its lighting along with efficient planning if it wants to increase its production. "When an employee sees better, he works better," Mr. Sturrock said. Of the factors that influence an employee's efficiency, a very important one is the lighting under which he works. As a production tool, artificial lighting can be good, bad, or indifferent and there can be little argument with the universal claim that lighting, conforming to sound engineering practices, increases production directly and indirectly.

Employees are becoming more and more conscious of their right to work under conditions favorable to their health, safety, and comfort. Mr. Sturrock declared that the war-production years gave many vivid examples of how improved lighting increases workers' efficiency and cited many examples of the importance of good vision among workers in industrial establishments and pointed out efficient ways. He also illustrated some proper types of lighting equipment that should be employed in industry.

The problems of lighting should be approached from the point of view of "ease of seeing," he said, because research has revealed that seeing is a task, accomplished not by eyes alone, but by the whole body in quite the same way that lifting a weight is not a task for the arm or back alone, but also has a tiring effect upon the heart, lungs, and the whole nerve fiber.

New Conveyer Systems

"Handling Bulk Materials Mechanically," by L. J. Carson, chief engineer, Pacific Division, Link-Belt Company, San Francisco, Calif., and "Almost a New Business Science," by John F. Johannsen, member A.S.M.E., manager, Export Division, Hyster Company, Portland, Ore., were the two papers given on materials handling. Mr. Carson explained that new developments in conveyer systems "put the materials to the operator in the least time and space" and therefore increased the plant operating efficiency. War-developed conveyer systems were distributed for the delicate handling of ammunition and also for the transportation of aggregate for Shasta Dam, for which there were 11 miles of belt conveyers.

"Methods developed for rapid transfer of essential goods to the fronts during the war can be applied to present-day industry," Mr. Johannsen stated. He advocated the arrangement and handling of goods in streamlined packages so as to save space and reduce inventory time. He also discussed the importance of materials handling by stating that 22 per cent of the total cost and 30 per cent of the total time is concerned with handling. It is these operations which represent a major problem since proper handling reduces operating costs and increases the rate of production. Many variables enter into the problem including type and weights of materials, transportation distances, available space, and plant capacity. In view of this situation and the need for improved materials-handling equipment, Mr. Johannsen expressed the opinion that materials handling is a valuable field for young engineers.

Shasta Dam Turbines

J. F. Roberts, member A.S.M.E., manager, Hydraulic Department, Allis-Chalmers Manufacturing Company, Milwaukee, Wis., presented the principal construction details of the 103,000-hp turbines for Shasta Dam. He discussed the various types of construction for the job-welded casing sections. Graphs were shown giving comparison of the properties of test casing specimens.

Herbert H. Sloane, engineer, Department of Design and Construction, U. S. Bureau of Reclamation, Denver, Colo., reviewed the various construction problems encountered in the removal of two turbines from the Shasta Power Plant in California to the Grand Coulee Power Plant in Washington. These turbines were removed to supply power for war-established industry in the northwest, thereby enabling shipyards to obtain the necessary electrical energy.

Applied Mechanics

An important problem in aircraft and boiler-plate work is the deflection, slope, and bending moment of thin square plates which are fixed by equally spaced points on the edges. This matter was the subject of a paper presented by Charles J. Thorne, associate professor of mathematics and astronomy, University of Utah.

The plates were assumed to be square with five equally spaced fixed points (such as rivets, spot welds, or bolts) on each side, in such a manner that each fixed point was symmetric regarding deflection and slope with fixed

points on the other sides of the plate. The load was first assumed to be uniform over the entire plate, and then center point-loaded. Boundary conditions needed for the solution were: The deflections of three fixed points, the slopes in the "x" direction of the three fixed points and the slope in the "y" direction of one of the three fixed points. The general solution of the deflection of any point within the plate was given as a sum of biharmonic polynominals with coefficients determined by the boundary conditions. These boundary conditions were discussed for several likely cases found in engineering problems. They were: Zero slope and deflection at the five points on a side, a particular slope and a particular deflection at the midpoints of the edges; and a tangential slope at two of the five points not specified.

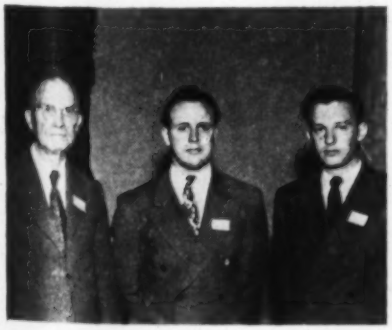
Several numerical solutions were obtained and compared with previous investigators of this problem. Graphs were drawn plotting deflections at the edges, the center line, and the diagonal. Slopes were plotted at the edges. Moments and stresses were given at the midpoint of the edges. A table of results compiled by the author paralleled this work.

Spreader Stokers

One of the most interesting papers of the meeting was that given by Otto de Lorenzi, fellow, A.S.M.E., director of education, Combustion Engineering Company, Inc., New York, N. Y., on the subject of "The Continuous-Discharge Spreader Stoker." He presented colored pictures of actual furnace and fuel beds which make possible the study of flow characteristics and turbulence conditions within the furnace. These showed the advantage of the use of kodachrome photography in the study and the improvement of heat-generating equipment.

After a brief introduction, Mr. Lorenzi proceeded to show a series of high-speed films of the actual burning of various coals in different types of units. In these films it was possible to observe a burning period of several hours in two or three minutes and to see the movement of the fuel bed from several angles.

J. F. Heath, fuel engineer, Utah Coal Operators Association, Salt Lake City, Utah, reported on the "Activities of Utah Coal Operators Association Looking to Increased Efficiency in Burning Utah Coals." His approach was directed in turn to the problems of the plant owner, management, and operating personnel, and results given on the outcome of several years of investigation of the problems of users and prospective users of Utah coals to solve the fuel, coal-burning, and smoke-abatement problems.



AT THE APPLIED MECHANICS SESSION

(*Left to right:* E. H. Beckstrand, member A.S.M.E., professor emeritus of mechanical engineering, University of Utah; Charles J. Thorne, professor, University of Utah; Reed G. Bills, industrial engineer, Denver Fire Clay Company, Salt Lake City, Utah.)

"Spreader Stokers" was the subject of a paper by R. L. Beers, member A.S.M.E., vice-president, charge of engineering, Detroit Stoker Company, Detroit, Mich. Although Mr. Beers was unable to be present at the session, a brief discussion of the important aspects was given by John Pearson, chairman of the session. Mr. Beers' paper first gave a history of the development of spreader stokers. The use of various fuels has required different types of stokers with modifications in furnace design. The spreader stoker handles this complete range of fuels better than any other type heretofore used, he said.

Among the advantages of spreader-stoker firing listed by Mr. Beers were: Ability to burn both high- and low-grade fuels; minimum of clinkering tendency; the grates have a long life; and low power requirements.

Kennecott Copper Power Stations

The final paper was delivered by George A. Parker, assistant mechanical engineer, Control Power Station, Utah Copper Division, Kennecott Copper Corporation, Garfield, Utah. This paper covered a brief history and discussion of the design, construction, and operation of a steam-electric power plant to furnish electric energy for the mining and milling operations of the Kennecott Copper Corporation, Utah Copper Division. The plant will have an installed capacity of 100,000 kw. Natural gas is used as the primary fuel and pulverized bituminous coal as the stand-by fuel. Operation for the first six months of 1947 with one 50,000-kw turbine generator and two 350,000-lb per hour boilers in service, resulted in average boiler efficiencies of 87.94 per cent, average turbine heat rate of 11,771 Btu per kw-hr delivered as useful power with 6.94 per cent for plant auxiliaries and an over-all thermal efficiency of 28.99 per cent.

An abstract of Mr. Parker's paper is published on pages 934 to 936 of this issue.

Panel Cooling

Paralleling recent development in radiant heat is a new method of panel cooling, by which building temperatures are reduced by means of embedded pipes. This method was discussed by C. F. Kayan, member A.S.M.E., and associate professor, department of mechanical engineering, Columbia University, New York, N. Y.

The basis of this method of cooling is that the cooling medium reduces the temperature of the surfaces below that of the space-air, thus creating an operating temperature difference over the surfaces in question. Since the flow of heat is analogous to the flow of electric current, a system of measuring the electrical potential by means of a Wheatstone-bridge arrangement was utilized. From these data, lines of constant potential (isotherms) were drawn around the cooling source. Pipe size and spacing, material conductivity, effective surface conductivity, and effective surface conductance values, were shown to determine the magnitude of the heat flow. Many of the effects were presented by electrical analogy to overcome the tedious and impractical presentation by mathematical or graphical methods.

AT THE SONS OF THE UTAH PIONEERS WEDNESDAY LUNCHEON

(George C. Lloyd, president, Sons of Utah Pioneers (*left*) presenting to Mervin B. Hogan, member A.S.M.E. and Salt Lake City program chairman (*right*), the actual key to the original wooden gate at south entrance to Temple Square, Salt Lake City. *Others, left to right:* O. Merdith Wilson, dean, School of Arts and Sciences, University of Utah, Salt Lake City, Utah; George Albert Smith, president, Church of Jesus Christ of Latter-Day Saints; and Richard L. Evans.)

Sugar-Beet Problems

"Temperature-Reduction Problems in Sugar-Beet Storage" was the title of the paper presented by R. D. Barmington, member A.S.M.E., associate research engineer, Colorado Agricultural Experiment Station, Colorado Agricultural and Mechanical College, Ft. Collins, Colo. Of primary concern was the problem of satisfactory storage of sugar beets prior to their processing. Sugar losses in the storage pile vary from one fourth to one pound of sugar per ton per day, depending on the temperature of the beet pile. The amount of heat given off by sugar beets in storage varies with the pile temperature, the higher the temperature, the more rapid the decomposition. Respiration of the living beet tissue consumes this sugar and gives off heat at the rate of 7098 Btu per pound of sugar. Therefore the problem is one of initially reducing the temperature of the sugar-beet pile and thereafter maintaining a reduced temperature by mechanical means.

It has been found that cooling the pile with a water spray or submerging the beets in water is detrimental, in that the excess moisture facilitates or encourages the growth of the beet. The investigation of a cooling process whereby an air ventilating system was used has not proved to be satisfactory up to the present time. Damage to the air ducts during the piling operation and the expense involved in blower installation leave much to be desired with this type of cooling.

Since sugar-beet decomposition in storage

represents an appreciable loss to the industry, extensive research now is being carried on in all sections of the country where this product is grown. So far, experiments have shown that a reduction in pile temperature is the most effective way of reducing the sugar losses.

Inspection Trips

Four interesting and diversified inspection trips were arranged for the afternoons of Tuesday, Wednesday, and Thursday. These trips covered locally the steel industry, the copper industry from mining to finished blister copper, and a very delightful and instructive geology tour conducted by the geology department of the University of Utah.

The Bingham open-cut copper mine of the Utah Copper division of the Kennecott Copper Corporation is located in the upper end of the narrow and V-shaped Bingham Canyon. The ore is loaded into railroad cars from the 38 working levels and switched to make up ore trains for hauling to the Company's two large concentration mills at Magna and Arthur, about 18 miles from the mine. The ore runs from 0.5 per cent to 2 per cent copper and is blended to about a 1 per cent copper ore before entering the mills.

The Magna mill and Arthur mill are only about three miles apart and are sister copper-concentrating plants of about the same capacity. The Magna mill was visited as it has the central power station.

From the power station, the inspection party was conducted through the Magna concentrating mill and was shown the complete cycle of operation necessary to process the ore from the low-grade material brought in to a copper concentrate containing about 35 to 38 per cent copper, which concentrate carries the small quantities of gold, silver, and molybdenum which are recovered as by-products.

Geneva Steel Plant

The Geneva Steel Plant which was built for the Government during the war as a plate mill was purchased from the Federal Government in June, 1946, by the United States Steel and operated by them as Geneva Steel Company along with their other Utah properties. Here on a plant area of 1500 acres they operate a coke plant of 252 modern ovens to make blast furnace, domestic, pea coke, and breeze. The plant has three blast furnaces with a capacity of over 1,000,000 tons of pig iron and has nine open-hearth furnaces for the production of steel ingots. The rolling mills produce slabbing and blooming-mill slabs, blooms and billets, plates and shapes. For this they produce large quantities of coal, iron ore, limestone, and dolomite. A power plant of 50,000 kw capacity produces power for the plant and for sale. A boiler plant of five large boilers equipped to burn natural gas and pulverized coal, as well as coke breeze, coke oven gas, and blast furnace gas furnishes steam for the plant. Complete shops for all sorts of maintenance work together with 73 miles of track within the plant site make for a balanced plant. Locker rooms and shower rooms are provided to accommodate all employees and the office buildings house the first-aid, welfare, public-relations, and local management offices. This plant is about 8 miles west of Provo, Utah, is close to Utah Lake which is a freshwater body and has a reservoir for plant use of over 300 acres. The Denver and Rio Grande Railroad and the Union Pacific Railroad serve this plant. Controls and operating records keep close check on plant operation at all times and latest and automatic electrical switching is used whereever possible.

Geology Tour Popular

The geology tour, conducted by the geology department of the University of Utah, was extremely popular and members and their wives who took this tour were enthusiastic in their praise. This tour took visitors from Salt Lake City up over the Wasatch fault, through Big Cottonwood Canyon on an excellent highway to Brighton. Brighton is one of Salt Lake City's main recreational and scenic spots. Dropping down to the base of the Wasatch range the tour followed south along the range to Little Cottonwood Canyon and up the canyon to Alta. Alta was once a silver-mining center with a population of 5000 hard-rock miners. Later it became a ghost town but now is renewing its activity in mining. Both of these canyons are rugged, well-wooded, have swift flowing streams of cold mountain water, and afford numerous camp and picnic areas built by the Forest Service for summer use. Alta and Brighton are great skiing centers and both canyons have headquarters' lodges for local mountain clubs. The geology of this country was related in a very interesting and instructive manner.

Committees

General committee: M. B. Hogan, chairman, G. W. Carter, D. A. Elkins, and H. L. Zetterman. Liaison Members: F. W. Beichley, S. L. Crawshaw, B. G. Dick, N. W. Humphrey, and V. A. Peterson.

Entertainment: A. J. Schindler, chairman, John Lang, and D. M. Schwartz. Finance: A. O. Gates, chairman, R. E. Kunkel, and W. D. Turpin.

Hotel and Train Reservations: D. A. Elkins, chairman, H. P. Lott, and L. C. Williamson. Inspection Trips and Transportation: H. L. Zetterman, chairman, L. Gordon Bywater, J. S. Pearson, L. Wayne Redd, Jr., and P. A. Woodruff.

Luncheons, Dinners, and Banquet: G. W. Carter, chairman, W. L. Moats, and A. J. Schindler. Program: W. F. Kempe, chairman, A. H. Blake, and H. J. Hassell.

Publicity, printing, and signs: M. B. Hogan, chairman, S. T. Johnson, and J. Cecil Sharp. Reception: G. W. Dansie, Jr., chairman, J. C. Billeter, W. J. Cope, G. M. Jones, W. H. Kelsey, and J. D. Roberts.

Registration: A. O. Marsh, chairman, W. R. Hansen, and E. M. Messersmith. Technical Sessions: G. W. Morgan, chairman, M. P. Egleston, M. C. Larsen, and W. R. Mahoney.

Women's Program: Mrs. E. H. Beckstrand, chairman, Mrs. M. B. Hogan, Mrs. A. O. Marsh, Jr., and Mrs. J. D. Roberts.

Reported by GEORGE W. CARTER
H. L. ZETTERMAN
STUDENT MEMBERS of
UNIVERSITY of UTAH

Do You Have This Volume to Sell?

VOLUME 52 (1) 1930 of the A.S.M.E. Transactions is needed by a member to complete his bound-volume set of the Transactions. If you have this volume and wish to dispose of it, please communicate with The Editor, MECHANICAL ENGINEERING, 29 West 39th St., New York 18, N. Y.

D. C. Engineers Draft Registration Bill

A BILL governing the registration and licensing of professional engineers in the District of Columbia has been drafted and appears to be generally satisfactory to each of the societies that belong to the District of Columbia Council of Engineers and Architects, according to the September issue of *The Washington Mechanical Engineer*, the monthly news letter of the A.S.M.E. Washington, D. C., Section. Action on the bill by Congress is expected early in 1948.

1948 Officers of A.S.M.E. Elected by Letter Ballot

AS reported by the tellers of election, F. D. Herbert, C. W. Obert, and J. J. Swan, letter ballots received from members of The American Society of Mechanical Engineers were counted on Sept. 23, 1947. The total number of ballots cast was 7208; of these 112 were thrown out as defective.

	Votes For	*Votes Against*
For President		
E. G. BAILEY	7196	12
For Regional Vice-Presidents		
To serve 2 years		
FRANK M. GUNBY	7194	14
PAUL B. EATON	7201	7
THOMAS E. PURCELL	7192	16
J. CALVIN BROWN	7194	14
For Directors at Large		
To serve 3 years		
JOSEPH B. ARMITAGE	7199	9
To serve 4 years		
ABBOTT L. PENNIMAN, JR.	7197	11
WILLIAM M. SHEEHAN	7195	13

The new officers will be introduced and installed in office during the Sixty-Eighth Annual Meeting of the Society to be held at the Chalfonte-Haddon Hall Hotels, Atlantic City, N. J., Dec. 1 to 5, 1947.

Biographical sketches of the newly elected officers were published in the August, 1947, issue of MECHANICAL ENGINEERING, pages 701 to 705.

I.I.R. Division's Second National Meeting Draws Large Attendance

THE tremendous growth of interest in instrumentation and automatic control among mechanical engineers was the theme underlying the second national meeting of the Industrial Instruments and Regulators Division of The American Society of Mechanical Engineers held at the Stevens Hotel, Chicago, Ill., Sept. 8 and 9, 1947. The meeting was in coincidence with the Second National Instrument Conference and Exhibit sponsored by the Instrument Society of America.

The presentation of five technical papers, the Division Banquet and address, the Division Luncheon, and the Division committee meetings were the main events.

Following the First National Meeting in Pittsburgh last year, the Second National Meeting heralded the continued growth of the I.I.R. Division, in keeping with the rapid postwar advances in the instrumentation science and its widespread recognition by the leaders of industry.

An unusually large number of foreign visitors representing many countries were in attendance at the meeting.

W. Julian King Speaker at Banquet

The climax of the program was the Division Banquet held in the Gold Room of the Congress Hotel on Monday, Sept. 8. More than one hundred and fifty members and guests were entertained by the well-planned banquet which featured a procession of beautiful sculptured figures in ice.

W. Julian King, director of the Sibley School of Mechanical Engineering, Cornell University, Ithaca, N. Y., was the main speaker and was introduced by the toastmaster, J. C. Peters, chairman of the Division.

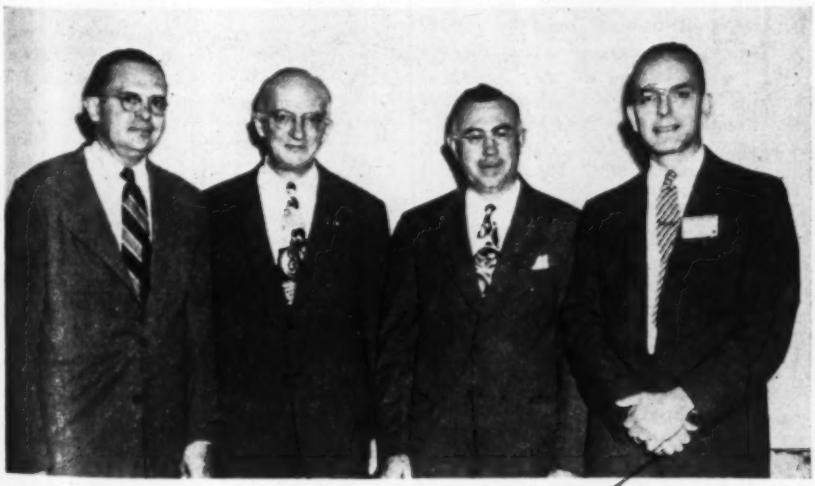
Professor King, who is esteemed for his famous essay on "The Unwritten Laws of Engineering," addressed an interested audience on "Personal and Professional Problems of Engineers—Common Aids and Barriers to Advancements." He spoke freely on the subject of ethics in the engineering profession, the problems of instilling confidence and social consciousness in the young engineer, and the factors influencing the professional advancement of the engineer. Emphasis was laid on the rules guiding the approach of the engineer to his relations with other engineers and with management. Professor King followed his talk with an open question period during which there was lively interest devoted mainly to the subject of the social and economic status of the engineering profession.

Pres. Eugene W. O'Brien followed Professor King with a discussion of the activities of the A.S.M.E. and in particular, the Engineers Joint Council in connection with the statistics recently gathered concerning the economic status of the engineering profession and its attitude on unionization.

Five Papers Presented

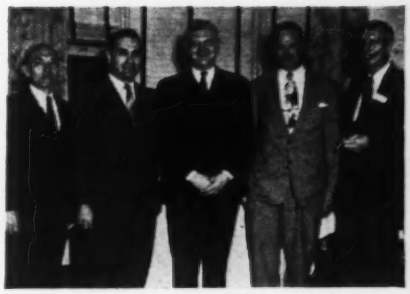
The technical program on Monday, Sept. 8, in the Grand Ballroom was well attended. "Applications of Mechanical Cascade Control Systems" was discussed by J. N. Swarr of the Corn Products Refining Company. In his paper Mr. Swarr emphasized that the progressive refinement of the continuous process has made it necessary to bring more and more variables under automatic control, a condition which has made it desirable and in many cases essential to provide control devices which could be combined in more complex ways. The development of the concept of the cascade controller placed a very powerful tool in the hands of the process control engineer.

"Floating Scale Manometers" was the subject of a paper by W. D. Wood of Taylor Instrument Companies. In it he described the development and design of an improved well-type manometer which utilizes a moving scale supported on a float and riding with the liquid surface, thereby allowing a constant reading level.



J. C. PETERS, CHAIRMAN, I.I.R. DIVISION, POSES WITH HONORED GUESTS AT THE SECOND NATIONAL CONFERENCE OF THE I.I.R. DIVISION

(*Left to right:* J. C. Peters; C. O. Fairchild, president, Instrument Society of America; E. W. O'Brien, president, A.S.M.E.; and W. Julian King, director, Sibley School of Mechanical Engineering, Cornell University.)



A.S.M.E. OFFICERS PARTICIPATE IN I.I.R. DIVISION CONFERENCE

(*Left to right:* Gustav Egloff, president, Chicago Technical Societies Council; R. M. Krause, chairman, A.S.M.E. Chicago Section; C. E. Davies, secretary, A.S.M.E.; T. S. McEwan, vice-president A.S.M.E. Region VI; and P. S. Exline, secretary, I.I.R. Division.)

"Design of Instrument Gears," presented by G. W. Kuntny of The Brown Instrument Company, discussed the problems encountered in the design of small gears and gear sectors of the precision type which are used in instruments and instrument type mechanisms. In many cases the accuracy of the instrument depends upon the precision manufacturing of its gears, and methods for obtaining correct center distances and proper tooth form.

"A New System of Humidity Measurement" was discussed by W. F. Hickes of the Foxboro Company. He described the principles of operation of an electrical primary element for moisture measurements in air in which the temperature at a resistance thermometer bulb is determined by the equilibrium exchange of moisture between a saturated salt solution surrounding the thermometer bulb and the air. The instrument is of the Wheatstone-bridge type and may be calibrated in terms of moisture content of the air.

Various mechanical and electrical digital calculators and their uses were reviewed in a paper by W. J. Eckert of the Watson Scientific Laboratories, Columbia University. An excellent discussion of the field of the calculating machine and its application to laboratory and plant services was presented. Machines of this type are becoming widely used in conjunction with industrial instruments of the more usual variety.

I.S.A. Instrument Exhibit Held

The exhibition room on the basement floor of the Stevens Hotel was devoted to a well-planned display by more than 138 exhibitors from various instrument manufacturers and from companies having allied products and services. The Instrument Society of America sponsored the exhibit, which was the largest and finest of its kind ever held. The booths were crowded throughout the opening hours with visitors, guests, members, engineers, and technicians, all actively interested in the progress of instrumentation and automatic

control. To many, the exhibit was undoubtedly one of the main attractions of the conference.

I.S.A. Holds Conference

The Second National Conference of the Instrument Society of America was held from Sept. 9 to 12 and included the presentation of 21 technical papers, a banquet, and a series of educational lectures, as well as the exhibit.

Committees

The following committees are to be congratulated for contributing to the major success of the meeting:

Industrial Instruments and Regulators Division Executive Committee: J. C. Peters, chairman, P. G. Exline, secretary, Everett S. Lee, H. F. Moore, John J. Grebe, and A. F. Sperry.

Committee Chairmen: John J. Grebe, C. F. Kayan, L. M. Van der Pyl, W. G. Brombacher, Charles H. Colvin, J. B. McMahon, Herbert Harris, Jr., R. D. Webb, and S. G. Eskin.

Chicago Section Executive Committee: R. M. Krause, chairman, J. D. Pierce, secretary-treasurer, L. M. Johnson, vice-chairman, H. L. Nachman, C. C. Austin, W. H. Oldacre, R. H. Bacon, and D. J. Bergman, chairman, Industrial Instruments and Regulators Division.

Arrangements Committee: D. J. Bergman and Charles W. Parsons.

Reported by D. P. ECKMAN.

1948 A.S.M.E. Mechanical Catalog and Directory Out

THE thirty-seventh annual A.S.M.E. Mechanical Catalog and Directory, 1948 edition, was distributed to A.S.M.E. members during October.

In its catalog section, manufacturers describe and illustrate many products of interest to mechanical engineers. This section is followed by a Directory which gives the user a practically complete and authoritative index to the following markets: Metals and alloys, power-plant equipment, power-transmission equipment, instruments, materials-handling apparatus, aircraft power plants and instruments, foundry and machine-shop equipment, heating, ventilating, and air-conditioning equipment, electric motors and controls, equipment for process industries, pumps, fans, compressors, and many other types of mechanical apparatus. A page-reference system in the Directory ties in with the catalog section providing descriptions of the desired machine or equipment.

According to the editors of the volume, it is the only book which covers the field of mechanical engineering so thoroughly.

A 20-page insert describing all A.S.M.E. publications, such as power test, boiler construction, and safety codes, American Standards, fluid meters, engineering biographies, bibliographies, research reports, and manuals, is included in this volume for the ready reference of A.S.M.E. members.

Cornish Engines

Following a report of substantial interest among American engineers in the preservation of Cornish engines in England, it was voted to appoint a committee to raise funds for the preservation of these engines without expense to the Society.

Appointments

The following appointments were approved:

Boiler Code Committee: C. A. Adams, H. E. Aldrich, H. C. Boardman, P. R. Cassidy, R. E. Cecil, F. W. Davis, A. L. Ely, V. M. Frost, W. P. Gerhart, W. D. Halsey, W. F. Hess, D. S. Jacobus, C. O. Myers, H. B. Oatley, A. L. Penniman, Jr., D. B. Rossheim, D. L. Royer, Walter Samans, J. F. Scott, J. W. Turner, S. K. Varnes, A. C. Weigel, C. W. Wheatley, and F. S. G. Williams.

Boiler Code Subcommittee on Materials: P. J. Smith.

Power Test Codes Committees: No 3 on Fuels, Arthur B. Hersberger; and No. 10 on Centrifugal and Turbo-Compressor and Blowers, Ralph M. Watson.

Education Committee: Charles A. Davis. (Advisory Member)

Guggenheim Medal Board of Award: J. Carlton Ward, Jr.

Engineers Council for Professional Development: R. L. Goetzenberger, to serve as A.S.M.E. representative on the Executive Committee of E.C.P.D.

Advisory Panel on Scientific Mobilization: C. E. Davies, secretary.

Actions of the A.S.M.E. Executive Committee

At a Meeting Held at Headquarters, Sept. 19, 1947

A MEETING of the Executive Committee of the Council was held in the rooms of the Society, Sept. 19, 1947. There were present: Eugene W. O'Brien, chairman; J. N. Landis, vice-chairman, F. S. Blackall, Jr., A. C. Chick, A. R. Mumford, W. H. Sawyer (Finance Committee), K. W. Jappe, treasurer, E. G. Bailey, president-elect, C. E. Davies, secretary, and Ernest Hartford, executive assistant secretary.

Foreign Members

Upon recommendation of the Finance Committee, it was voted to continue the current policy regarding payment of dues by members in foreign countries for two years. The policy requires all dues to be paid in United States dollars with one exception: dues of Canadian members may be paid in Canadian dollars if payment is made on or before December 1 of each year.

Additional Space

Upon recommendation of the Finance Committee, a sum of money was appropriated to provide additional space for increased staff made necessary by a new activity, *Applied Mechanics Reviews* and the new plan for publications. Approximately 1500 sq ft of floor space will be occupied on the seventh floor of the Engineering Societies Building and the space now being used on the sixth floor will be relinquished.

Resolution of Thanks

On behalf of the Society, a resolution of thanks was extended to the local executive committee, other local committees, and all oganizations and individuals of the A.S.M.E. Salt Lake City Section who contributed so much to the success of the Fall Meeting.

International Standards

On invitation from the American Standards Association, the Boiler Code Committee was authorized to assume the secretariat of an International Standardization Organization project for a safety and design code on boilers and unfired pressure vessels.

Student Copies of Mechanical Engineering

It was noted that beginning with the October, 1947, issue, student copies of MECHANICAL ENGINEERING complete with advertising pages, will be mailed individually to about 11,000 student members. During the paper shortage, student copies contained only text pages and were mailed in bulk to honorary chairmen for distribution.

A.S.E.E. Headquarters to Be Moved

THE headquarters of The American Society for Engineering Education will be moved from the University of Pittsburgh, Pittsburgh, Pa., to the Northwestern University, Evanston, Ill., it was recently announced by C. E. MacQuigg, president of the A.S.E.E.

Prof. Arthur B. Bronwell of Northwestern University was appointed secretary of the Society. His appointment became effective Oct. 1.

F. P. Zimmerli to Receive Sauveur Award for 1947

F. P. ZIMMERLI, member A.S.M.E., chief engineer of the Barnes-Gibson-Raymond Division of the Associated Spring Corporation, Detroit, Mich., has been elected to receive the Albert Sauveur Award for 1947 of the American Society for Metals in recognition of "his basic research in the field of shotpeening to increase favorable stresses in the surfaces of metal parts."

Mr. Zimmerli's process consists of blasting metal surfaces with small steel balls at speeds approaching those of rifle bullets. The process increases the hardness and fatigue life of the metal surface.

The award is the highest given by the A.S.M. for technical achievement. It was presented to Mr. Zimmerli at the A.S.M. annual banquet in Chicago, Ill., Oct. 23, 1947.

Executive Committee Approves Policy on A.S.M.E. Committee Appointments

THE following statement of policy and procedure on A.S.M.E. committee appointments was recommended by the Organization Committee and was approved by the Executive Committee at its meeting of Sept. 19, 1947.

General Society Policy

The successful functioning of Society committees is one of the most important concerns of the officers of the Society; in fact, the effectiveness of the Society stems directly from the composite performance of hundreds of individuals serving on committees.

The Constituton and By-Laws regulate committee work but in addition, the statement of certain broad policies is necessary.

Committee work is one of the most valuable opportunities for members to make concrete contributions to the work of their profession. These committee opportunities occur in all phases of Society work, in boards and committees of national responsibility, in codes, research and standards, in professional divisions, in sections, and for students and student branches. Many committees are administrative, some requiring only general knowledge while others call for particular experience, such as finance, publication, and program making. Other committees with technical functions may require specialized technical knowledge and experience.

To promote the effectiveness of committee work, the following statements of policy have been adopted for the aid and guidance of all Society committees.

Committee Operation

(1) The function and objective of each committee must be clearly defined. The functions of standing boards and committees are stated in simple language in the various regulations of the Society. The functions of special committees will be stated when the committee is organized. In most cases the function of each committee requires a statement in more detail than is given in the regulations or appointing authority. It is a primary duty of each committee to state its function in whatever detail is needed to execute its mission properly. An objective for each committee is also necessary. The statement of objective should include time limits for the attainment of the objective in whole or in part.

(2) Inactive committees should be reorganized or disbanded. Where committees have necessary functions but their work is ineffective, reorganization is an obvious necessity. Where functions may not be basically necessary, the functions should be reviewed, their importance determined, and if unimportant the committee should be disbanded. Obviously, committees having special assignments should be discharged with thanks upon completion of the assignment.

Selection of Committee Personnel

(1) The special qualities needed in the personnel of a particular committee must be clearly stated.

(2) Good men must be selected for each committee assignment. The qualifications of the ideal man will include: (*a*) The obvious qualities of vision, imagination, and initiative needed for success in any venture; (*b*) loyalty to the Society and interest in its well-being; (*c*) experience and trained judgment closely related to the work of the committee for which he is being considered; (*d*) good committee personality; easy to work with; (*e*) facilities for performance of committee work; (*f*) for continuing committees, where each is expected finally to serve as chairman, each appointee should have the qualities of a good chairman and he should have a good presence and be a good presiding officer; and (*g*) support of his principals or business partners.

(3) In the interest of good age distribution, committee membership should include younger men who meet the necessary qualifications. This is important for the future of the Society.

(4) In committees national in scope, due regard must be given to geographical representation within practicable limits. One solution to the problem of geographical representation on committees might be to scatter the committees themselves, selecting the membership of any one committee from some limited area. This may not be satisfactory for continuing committees, and some effort should be made to select committee members who normally can travel to attend meetings.

(5) Committee work should be spread as widely as possible. It is doubly unfair to overload a willing worker and by that overloading keep others from the opportunity for committee service. In a society as large as ours, with its large collection of skills, only occasionally will it be necessary to require one man to serve on more than one or two important committees.

(6) Committee personnel should change. On committees with functions that carry on continuously, a proper turnover rate must be established so that new blood may be brought in while continuity of policy is preserved. The Society, for many years, has found 20 per cent per year to be advantageous for its standing committees, whose members serve five-year terms. For continuing committees, individuals who are retiring from service will not be reappointed for a full term unless it is necessary to meet exceptional circumstances.

(7) *Non-Members:* While it is recognized that distinguished specialists in other fields than mechanical engineering are required on many of our committees, nominations of non-members for committee appointments must be accompanied by statements that members of equal standing are not available for service on such committees.

(8) *Alternates:* In some committees it is desirable for the committee to appoint alternates for members who occasionally find it impossible to attend the meetings.

(9) *Balanced Interests:* Conscious effort should be given to secure a balanced personnel which represents the several fields of interest affected by the work of the committee.

Review of Committee Operation

A review of committee operation should be made annually by the agency to which the committee reports, preferably when the committee submits its annual report.

Procedure for National Committees

The following procedure will be used for all committees that come under the appointive power of the Council. These include boards, standing committees, representatives of the Society on other bodies or in connection with other nations, and important subcommittees. It is not applicable to regional or local committees.

Committee Objectives and Personnel Qualifications

The Organization Committee will maintain a *Committee Operation Manual* which will contain a statement of the objectives of each committee of the Society. This manual will also contain the qualifications desired in the personnel of the committees and representatives of the Society on joint bodies. These statements of objectives and desired qualifications should be supplied by the individual committees and be approved by the Boards under which they operate. This manual will also contain a list of committees and individual positions subject to this procedure, with a record of the agencies that have the functions of nominating, reviewing, and appointing personnel.

Nominations

The nominations for a committee appointment should show that the nominee has the special and general qualifications needed for the particular committee. Generally, this information should be secured from sources other than the nominees. For continuing committees the primary nominating responsibility rests with the committee itself. For special committees, the nominating responsibility rests with the supervising agency of the proposed committee.

Consultation With Nominee

Consultation with the nominee previous to his appointment may at times be advisable in order to make sure of his qualifications and availability, although ordinarily this information should be obtained from other sources. Care should be taken, however, to make clear to him that such a consultation does not assure an appointment. Securing the acceptance of an individual for service on a committee frequently affords a needed opportunity to secure the understanding of the nominee's principles. In general, it is desirable to obtain the consent of the nominee after his name has been approved but before the formal letter of appointment is sent.

Year-End Appointments

For committees with annually appointed memberships and special committees which

are reviewed annually, nominations will be received by the Organization Committee or other reviewing agency by August 1 of each year and will be considered by the Executive Committee at its October meeting so that appointments may be completed and the appointees may participate in the deliberations of their committees during the Annual Meeting.

Formal Appointment

The President will sign the formal letter of appointment.

1947 Machine Tool Show and Congress Draw Record Attendance

AN attendance of over 175,000 visitors at the 1947 Machine Tool Show, held under the auspices of the National Machine Tool Builders Association at the Dodge-Chicago plant, testified to the need on the part of industry for information on new machine tools and new methods.

Nearly 300 exhibitors were represented by over 2000 machines, which varied from small hand tools to 60-ton special-purpose machines. The universal interest in new developments was also exemplified by the unusually large number of visitors from Europe and South America.

The Tool Show, as a whole, was exceptionally well planned and managed.

A number of other societies and organizations including the A.S.M.E. combined with the National Machine Tool Builders Association to make this an outstanding tool show and to make the meetings of the Congress of major interest to industry.

The lapse of twelve years since the last Tool Show was held was reflected in the highly specialized machines for production purposes and by the size of the machine tool show.

Developments brought about by the need for high production during the war, as well as the use of carbide tools, has, to a considerable extent, revolutionized machine-tool design. High-speed milling attained through the use of carbide tools has become generally accepted, but planers capable of cutting at a speed of 400 ft per minute attracted considerable attention.

Another outstanding development was the retractable milling cutter made necessary by the sensitivity of carbide-cutting tools to drag over a machined surface on the return stroke. Hydraulic and electronic controls have added materially to the speed and accuracy of today's machine tools. Profile turning by which patterns can be reproduced is a new phase in lathe work.

The American Society of Mechanical Engineers contributed to the Machine Tool Congress through two evening meetings held by the Production Engineering Division, The Special Research Committee on Metal Cutting Data and Bibliography, and the Machine Design Divisions of the Society.

Papers on form grinding, arc welding, machinery structures, practice and theory in carbide milling and recent development in carbide application attracted capacity audiences.

A.S.M.E. Calendar

of Coming Events

Dec. 1–5, 1947
A.S.M.E. Annual Meeting
Atlantic City, N. J.

March 1–6, 1948
A.S.M.E. Spring Meeting
New Orleans, La.

May 20–22, 1948
A.S.M.E. Oil and Gas Power Division Meeting
St. Louis, Mo.

May 30–June 5, 1948
A.S.M.E. Semi-Annual Meeting
Milwaukee, Wis.

Sept., 1948
A.S.M.E. Fall Meeting
Portland, Ore.

Nov. 28–Dec. 4, 1948
A.S.M.E. Annual Meeting
New York, N. Y.

70 Sections and Student Branches Visited by President O'Brien

DURING the year, President O'Brien devoted a great deal of time and energy to the business of the Society. He visited 35 Sections and as many Student Branches in all parts of the country. In August alone he spoke before seven Sections and nine Student Branches in such widely scattered A.S.M.E. Sections as Kansas City, Oregon, and San Diego.

Approximately one half of the Sections and one fourth of the Student branches heard President O'Brien speak on topics close to his heart, such as the professional problems of the young engineer and the Society's contribution to the advancement of the engineering profession.

A.S.M.E. Helps in Pressure Vessel Research Program

MEMBERS of The American Society of Mechanical Engineers are active in a pressure-vessel program costing $75,000 a year which has been undertaken by the Welding Research Council of the Engineering Foundation.

In a recent statement reporting progress, A. B. Kinzel, chairman of the board of the Engineering Foundation, explained the aims of the program as those of "developing information and data which will lead to better, safer, and more economically constructed pressure vessels."

Walter Samans, member A.S.M.E., Sun Oil Company, Philadelphia, Pa., is chairman of the project's general committee which is made up of 87 representatives of manufacturers and users of pressure vessels, insurance companies, educational institutions, and branches of the U. S. Government. Mr. Samans is a member of the A.S.M.E. Boiler Code Committee and has been for the past three years chairman of the Subcommittee on Unfired Pressure Vessels of the Boiler Code Committee.

The pressure-vessel research program was initiated by the Welding Research Council and receives its principal financial support from industry. In addition to the A.S.M.E., several other engineering societies are cooperating in the program.

Prizes for Technical Articles Offered

THE Industrial Furnace Manufacturers Association has announced the I.F.M.A. Prize Contest to promote the publication of more and better articles in the technical press describing the economic advantages obtained by the use of modern industrial furnaces, kilns, and ovens. Papers published between October 1, 1947, and September 1, 1948, will be eligible for $1500 in prizes. A.S.M.E. papers published in MECHANICAL ENGINEERING are eligible.

Competition in the contest is open to all individuals or groups with the single exception that they must not be connected with the industrial-furnace, kiln, or oven industry.

Formal rules and other details can be obtained from the I.F.M.A., 420 Lexington Avenue, New York, N. Y.

T. von Kármán Awarded John Fritz Medal

THE John Fritz Medal for 1948 was awarded to Theodor von Kármán, member A.S.M.E., and director, Guggenheim Aeronautical Laboratory, California Institute of Technology, Pasadena, Calif., it was announced recently by N. E. Funk, vice-president A.S.M.E. Region III, and chairman of the Board of Award.

The award was made in recognition of Dr. von Kármán's work as "creative leader, stimulating teacher, and wise counselor in engineering and physical research in the fields of the aeronautical and structural sciences, for his many applications of mathematical and physical theory to the sound solution of engineering."

The medal presentation will be made at the banquet of The American Society of Mechanical Engineers during the Society's 1947 Annual Meeting at Chalfonte-Haddon Hall Hotels, Atlantic City, Dec. 1 to 5, 1947.

The John Fritz Medal is awarded jointly each year by the American Institute of Mining and Metallurgical Engineers, the American Society of Civil Engineers, and The American Society of Mechanical Engineers. The medal

A.S.M.E. Junior Forum

COMPILED AND EDITED BY A COMMITTEE OF JUNIOR MEMBERS, C. H. CARMAN, JR, CHAIRMAN

The Ball Begins to Roll!

LAST month the editors outlined the purposes and aims of the *Junior Forum*. Briefly, these are to make the *Junior Forum* a clearing house for junior ideas, comments, and opinions; to encourage junior participation in Society affairs; and to make available to all members a convenient source of information on the trends of professional thought among young engineers.

To start the ball rolling prepublication copies of the October *Junior Forum* were sent to the chairmen of various Junior Groups for comment. Before going to press a reply was received from C. G. Tupling, junior member, Bearing Sales and Service, Inc., Portland, Ore. Mr. Tupling's letter and others follow:

Oregon Section Encourages Juniors

To the Editors:

THE material for the October *Junior Forum* was read with much interest. It is apparent that the editorial committee is determined to do a good job from the start. The initial text reads well, and is, I believe, the sort of information in which a junior member is interested. Junior engineers are interested in the future of the profession.

As for Mr. Purcell's talk we here in the Pacific Northwest have not been much concerned with unionization. At least it has not come to my attention. There are, however, many other pertinent factors concerning this business of being an engineer. Some of these are advice and encouragement to recent graduates by older members, particularly to the taking of state board examinations, and greater activity and attendance at local meetings.

In the Oregon Section the junior members partake in local activities on about the same basis as members—even to the extent of filling many section offices. In fact, it is recalled that in one prewar year all major offices were held by juniors. However, much remains to be done.

At this time I am not in favor of separate Oregon sections. It is my thought that our section is weak at present and to separate the juniors will be an error. It is going to be necessary for all local members, whatever their status, to assist in building up the section in these next few years. It is my opinion that the *Junior Forum* will be of great service in this regard as well as to the Society as a whole.

C. G. TUPLING.

"Responsible Charge"

To the Editors:

WOULD you rather be classed as an associate member after reaching the age of 33, if you are not by then a member? In at least one of the other big engineering societies, they automatically change a junior's grade at age 33, either to associate or to member. Is it not a little absurd and degrading to the engineering profession to call an able engineer of 45 a junior? He may have been the "good right arm" of an executive-in-responsible-charge for some years; he may be respected and depended upon for his engineering judgment by many business associates; and yet he cannot conscientiously claim that he has been in responsible charge at all.

Now let me approach this question from another angle. To do so necessitates first taking a few paragraphs to discuss some unusual definitions. These are not the definitions you see in print customarily. However, each one roughly represents the unexpressed tenet of a large group of engineering-society members.

Who Is an Engineer?

One group of members would say that an engineer is one proved qualified to design engineering equipment. And when they say design, they mean a use of the scientific, theoretical, analytical, and mathematical approach to nonroutine problems.

Another group would say that an engineer is one proved capable of responsible supervision of important engineering work. Those in this group assume that this supervision involves frequent use of much engineering knowledge—which it may or may not.

A third group of members would say that an engineer is one who has proved himself trustworthy of applying engineering knowledge in any of several activities, including designing, selecting, testing, operating, selling, constructing, editing, consulting, or layout planning, if this application is not on routine problems, that is, if it requires judgment.

Now there are a good many men who might meet all three of these rough definitions. More power to them! But there are many more who find themselves pretty well "classified" in one, or in one and a half of them. For instance, those whose aptitudes and interests have fitted them peculiarly for the design side of engineering, and who have been qualified or recognized, feel no doubt about their right to being classed as engineers, or as members. Not many of them do much actual supervising, except in so far as their verbal instructions to machinists and technicians regarding their designed parts can be considered supervision. Usually their "responsible charge" is the charge of their own designs, rather than of projects or persons. Their approach is also usually too theoretical for continued success as application engineers, so most of the design engineers fit into the first category only.

Management Versus Engineering

Again, those who have the aptitudes and interests fitting them particularly for supervision and executive responsibility (not necessarily leadership) and who have used engineering as a "vehicle" for their supervisory abilities, see no reason why they should not be called engineers, or members. Many of them are, in truth, very able designers or "appliers" as well as supervisors. But many others who are in responsible charge of important engineering work would voluntarily disclaim the term "engineer," so the second definition cannot be considered valid by itself alone.

The many more who would class themselves in the third group (applying engineering knowledge) feel just as deserving of the term engineer, or member. They may lack the aptitudes for managing men, or for "managing" the more abstruse mathematics and theory, but they have other aptitudes just as useful in the engineering profession. Their engineering experience and their balanced judgment are both in demand. Much depends on them.

In differentiating the empirical practical art from the scientific analytical approach to practical problems, Karl T. Compton, the president of M.I.T., said, "Both are extremely necessary, both are fields of concern to us."

Must we continue "officially" to regard our experienced practitioners of the "empirical practical art" as junior members?

Some Action Needed

Even assuming that the consensus of A.S.M.E. membership would grade as members only those proved capable of responsible charge, shouldn't we change a junior's grade to associate, or to member, when he reaches a mature age, say 33?

It may well be that a principal reason why so many able mechanical engineers shun the A.S.M.E. is this psychological effect, the resentment in expectation of being classed a junior.

IRVING TAYLOR.[1]

What About Registration?

To the Editor:

MUCH has been written recently regarding the need for improved organization among and within the various engineering technical societies if our profession ever hopes to attain the degree of public recognition and respect afforded to the law and medicine, and if the activity of the labor unions in attempting to unionize professional engineering is to be successfully minimized. In my opinion the means at our disposal for accomplishing these objectives lie in the state registration laws.

It does not appear to me as if the engineering

[1] Mem. A.S.M.E., Pump Engineer, Lummus Company, New York, N. Y.

colleges make any effort to acquaint their graduating students with the existence of registration laws and the desirability of obtaining qualification certificates. Neither has the A.S.M.E., to the writer's knowledge, made any effort to publicize state registration as a means of strengthening the individual engineer's competence, promoting his professional consciousness, and improving the public's understanding of the significance of his work. His attitude might be attributed to the fact that our state registration laws at the present time are not uniform in all respects and do not adequately cover those branches of engineering besides civil engineering. The educators and technical societies should not let the existence of such a situation deter them from advocating registration of all who work in engineering fields, for some plan is certainly better than no plan. With the educators and technical societies actively supporting registration they would be in a position to effectively lobby to attain improvements and correction of defects in the existing laws so that ultimately the professional status of engineers could be firmly established with employers and the public.

J. M. SEXTON.[2]

Suggested Reading

IN THE flood of current literature there appears from time to time a book of special interest to the young engineer, because it peers with remarkable insight into the problems of professional development or conveys information which he can use with profit. The editors intend to seek out these books and to review them in these columns. Such a book is Lorie Brophy's "There Is Plenty of Room at the Top." The following review was prepared by Donald E. Jahncke, chairman, A.S.M.E. Junior Committee.

How to Get to the Top

THIS is a book[3] which all young men who want to get to the top in the business world should read. Specializing in the placement of men in jobs which pay $10,000 a year or more has given the author a keen insight into the hearts and minds of executives on the way up. Miss Brophy presents cold hard facts on how to act in considering new jobs—what obstacles to expect and how to overcome them when on the job. She discusses fearlessly what many executives must face in office politics, family relationships in business, executive intrigue. She tells management how to select executives and how to handle them to bring out their best. Miss Brophy discusses many of the nuances of discretion which frequently mean the difference between getting a promotion or not getting it. While the book is written primarily for people in the sales and advertising fields, it points out many of the things which engineers most frequently forget.

Make a Plan

If you have decided that you cannot be happy in your business life except at the top, one of your earliest duties should be to make a realistic long-term plan for your future. Be sure the field you select will provide broad opportunities in later years as well as at the beginning. If you find you are in the wrong field, analyze your abilities and talents—you may discover untapped resources that will bring striking success in another. Estimate your worth accurately. You will be paid in terms of what you think of yourself.

Should You Change Jobs?

Miss Brophy discusses at length the pros and cons of changing your job. She emphasizes that before making any decision to change your job, a thorough study and consideration be made of, first, your own likes and dislikes; second, the opportunities which your present job offers for the satisfaction of these likes and dislikes; and, third, the opportunities which some other job—possibly in a different field—would offer. All too many men jump blindly from one job to another without ever taking sufficient time to adequately study the situation. One of the unusual points which she brings out is the consideration of whether you as an individual have a "large corporation" personality or whether you would be happier in a small-company atmosphere.

If, after careful consideration, you decide to change your job, Miss Brophy discusses the most effective way of conducting your interviews to be sure you get the job you want. She emphasizes that it is just as important for you to know specifically what the job calls for as it is for the employer to know your exact qualifications for it. Many men have accepted jobs which have proved entirely unsatisfactory because a clear understanding was not reached beforehand on just what their duties and scope of responsibility would be.

Importance of Human Relations

While it is necessary for you to develop your technical skill and maintain your contacts with either the people in the shop or your customers on the outside, do not neglect your associates. In most instances your future will rest upon the skill with which you handle these human relations. Miss Brophy says that you MUST be a politician. Some men resent this and disclaim any intention of being a politician. This is a highly unrealistic attitude. It is useless for a man to say, "I don't want to get into any politics," because by being in a business organization, he is already in politics whether he wants to be or not. In every company, large or small, a constant, though perhaps concealed, war for show and place is inevitably going on. The crux of the matter lies in what is meant by the world "politics." It is true that in some cases it refers to a cutthroat maneuvering with little regard for ethics, but in another sense the word simply means putting "your best foot forward" and smoothing out any personal relations which you have with your colleagues or employees.

The author discusses the techniques of overcoming those apparently inevitable personnel difficulties which seem to plague most organizations. While there is no one clear-cut answer to many of these problems, she suggests several "Machiavellian" approaches which have proved successful in the past.

She urges that good care be taken of your health because it is only when your body is in tiptop condition that you are able to utilize fully your mental faculties and creative abilities.

Do You Need A Raise?

To a man forging ahead in his career, the amount of money he makes means more than the actual sums involved. Raises along the road are signposts indicating the progress toward an ultimate goal. If these raises do not occur at fairly specific points along the way, his chance of reaching his objective will be seriously limited.

Negotiating a raise is an extremely difficult and subtle operation. It is a balance of your wits and ingenuity against those of the boss. Unfortunately, it is the policy of all too many companies to give raises only when they are forced. Unless you have good specific reasons for requesting a raise, it is better not to approach the boss directly. It is far better to plan your statements and wait for a suitable opportunity when you can plant the idea in your boss's head so that he will think it is his own idea.

To continue to advance you must put each raise to good usage. While the virtues of thrift and saving are very desirable, if you want to grow in the business world, you must reinvest a part of each raise you receive in expanding your mode of living. Miss Brophy compares this operation to that of a business plowing back part of its earnings into better equipment.

Take Advantage of Opportunities

In the closing chapter Miss Brophy repeats her previous implication that you should not "fight success." To really advance in the business world it is necessary to take advantage not only of the big opportunities that present themselves but also of the many small chances which come your way. Failure to take success by the forelock frequently stems from a fundamental misconception. Men assume that moments of opportunity arise only under special circumstances, or they think that these are the logical rewards for merit and come only as concrete offers, dramatically presented. Yet success almost never follows a rational course that is apparent on the surface. On the contrary, the most fertile opportunities spring from what seem to be the most unlikely circumstances as well as the most prosaic situations. They often appear in the guise of casual events that seem to hold no promise whatever and may occur off the beaten business path at wholly unexpected moments. Unless instantly recognized and boldly exploited, they may flash by and are lost forever.

Miss Brophy urges young men to read—read—read. She has found in her experience that no single thing is more conducive to executive advancement than a large vocabulary and a broad knowledge of fields other than your own. She also recommends that each individual write

[2] Mem. A.S.M.E., Materials Inspection Engineer, M. W. Kellogg Company, New York, N. Y.

[3] "There Is Plenty of Room at the Top," by Lorie Brophy. Simon & Schuster, New York, N. Y., 1946, cloth, 5½ × 8 inches, 160 pp., $2.50.

an autobiography every six months to help him evaluate his strong and weak points so that he can intelligently capitalize on the strong ones and study to overcome the weak ones.

DONALD E. JAHNCKE.[4]

News Notes

Junior Gathering at Atlantic City

IN October it was suggested that junior members who are in attendance at the Annual Meeting in Atlantic City meet to discuss the reactivation of Junior Groups among the Sections and other matters of interest to younger members of the Society. Because time does not permit more formal arrangements, the present plan is to hold an informal gathering in one of the available rooms on Monday or Tuesday. There will be a notice on the registration desk giving specific instructions and you will be invited to indicate whether you intend to be present. In addition to a review of junior affairs by the A.S.M.E. Junior Committee, an agenda will be prepared to spark the discussions. Watch for the placard and plan to be present.

Committee Service

It has been the traditional practice of the Society to have junior members represented on A.S.M.E. administrative committees by two of their own number. For some time these representatives have been appointed from the junior members residing in the New York area to enable them personally to attend committee meetings. While personal attendance is stimulating, it is not essential. Junior members living away from New York who are interested in serving on the committee can do so by correspondence, that is, they can receive minutes of the committee on which they serve and comment by correspondence on actions taken.

The Junior Committee encourages such service as one of the best ways for junior members in the Sections to learn directly how the work of the Society is carried on. If you want to serve in this manner on Society administrative committees, write to the editors and they will start the ball rolling.

Keep the Pot Boiling

If these columns are to become a boiling pot of comments and letters from which can be distilled the ideas which dominate now the thinking of junior members and which may in the future determine the actions of the Society, junior members must participate in the *Junior Forum*. Address correspondence to C. H. Carman, Chairman, *Junior Forum* Editorial Committee, A.S.M.E., 29 West 39th St., New York 18, N. Y.

[4] Jun. A.S.M.E., Engineer, Plymouth Division, Chrysler Corporation, Detroit, Mich.

Sections

Talk on Patents Opens Akron-Canton Section

A dinner and lecture featured the Sept. 18 meeting at the Women's City Club, Akron, Ohio. Albert H. Oldham spoke on "Famous and Funny Patents." He told how to obtain a patent and described the workings of the U. S. Patent Office; explained some of the patents that were odd, or funny, or famous, and which have had considerable bearing on our lives, industries, and progress in general. Slides illustrated the talk. Numerous questions were answered concerning patents in the quiz period which followed the lecture. Forty-two were present.

Diesel Locomotives Subject at Boston Section

A meeting was held on Sept. 25, at Massachusetts Institute of Technology, Cambridge, Mass., with 75 members present. The speaker was Clair B. Peck who spoke on "Diesel Locomotives." Mr. Peck described the different types of Diesel locomotives used on the American railroads, and called attention to their salient features. Comparisons were made with modern steam locomotives both as to operating characteristics and cost statistics. Slides were shown to bring out the various points.

"Inside A.S.M.E." Subject at Dayton Section

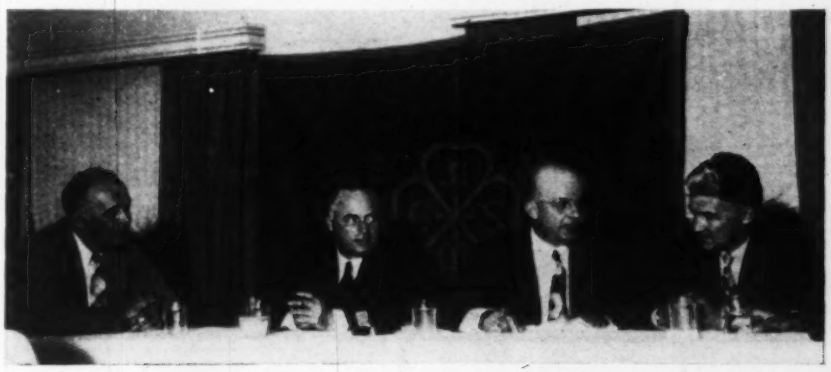
On Sept. 9 at the Engineers Club, Dayton, Ohio, an audience of 21 heard Ernest Hartford, executive assistant secretary A.S.M.E., speak on "Inside A.S.M.E." Mr. Hartford presented a very interesting review of the organization and the activities of the Society, followed by a discussion of the problems of Society growth both in number of members and in scope of technical activity, which gave the members a fuller appreciation of the value of the Society to the individual member, to the profession, and to society in general.

Kansas City Section Starts New Season

The first meeting of the season was held on Sept. 8 at the University Club, Kansas City, Mo. A meeting of the executive committee preceded the dinner, at which time visitors and new members were introduced. The program consisted of a sound film "Tornado in a Box," a product of the Allis-Chalmers Manufacturing Company. This film presented the history, research, and development of the gas turbine. Frank R. Hunter, Jr., of the local Allis-Chalmers office, gave a talk on the "Gas Turbine," further clarifying the details of design and application of the gas turbine to industry and transportation. Sixty-five were present.

Milwaukee Section Visits Nash Motor Plant

On Sept. 10 an interesting trip was made by 70 members to the Kenosha plant of Nash Motors. After the trip the members drove to Racine, Wis., for a dinner meeting at the Hotel Racine. Earl L. Monson, development engineer, discussed "Engineering at Nash," which was followed by many questions and answers regarding the future trend of automobile design. The speaker gave a concise picture of the engineering development and research departments as they were in the beginning and explained how they gradually expanded to their present size and importance. Mr. Monson gave a complete picture of the entire Nash organization, including the research branch at Detroit, Mich.; the engineering and testing departments at Kenosha, Wis.; and his company's proving grounds at Burlington, Wis.



HEAD TABLE AT A.S.M.E. MILWAUKEE SECTION DINNER MEETING
(*Left to right:* Theo. Eserkaln, Harold Heywood, section chairman; Earl L. Monson, speaker, and Warren Colwell.)

PHILADELPHIA SECTION HAS NEW CHAIRMAN
(*Left to right:* Outgoing chairman, Sidney T. Mackenzie, passing on the gavel to Merwyn C. Randall, incoming chairman, at a dinner given by the Section.)

Fall Smoker Starts Season for Schenectady Section

The Section held its fall smoker on Sept. 18 in Ten-O-One Hall, Scotia, N. Y., with 80 present. This meeting was for the purpose of having the members become acquainted with each other, and to invite guests to join the Section.

I. M. White, Engineer, Speaker at San Francisco Section

On Sept. 25 at the Engineers Club, San Francisco, Calif., "Design Problems of the Grand Coulee Pumps" was the subject of a talk by Ira Morgan White, member A.S.M.E., chief engineer, Pelton Water Wheel Company. Mr. White gave an informative talk on the world's largest pumps being constructed for the Grand Coulee Dam. The Byron Jackson Pump Company and the Pelton Company are producing six 65,000-hp pumps costing more than a million dollars each, for the U. S. Bureau of Reclamation. The attendance was 60. Announcement was made by the chairman that Dean George Sullivan, Fellow A.S.M.E., of the University of Santa Clara, was selected by Governor Warren to represent the mechanical engineers on the examining board for the new California Professional Engineers Registration Act.

West Virginia Section Has Dinner Meeting

On Sept. 29 at the Charleston Women's Club, Charleston, W. Va., F. R. Benedict, Westinghouse Electric Corporation, Pittsburgh, Pa., spoke on "Engineering Materials of the Future," before an audience of 80. This was a demonstration type talk concerning materials of construction which are or soon will be available for use by the designer and practicing engineer for practical solutions of everyday engineering problems. A dinner preceded the meeting.

Worcester Section Hears Prof. L. J. Hooper

On Sept. 25 in the Alden Hydraulic Laboratory of the Worcester Polytechnic Institute, Prof. Leslie J. Hooper gave a talk on "Recent Work at the Laboratory," illustrated with high-speed movies. He described the equipment and method used in studying what happens when objects strike water at various angles and speeds. Fifty were present.

Youngstown Section Hears T. E. Purcell

The fall program was opened with a meeting on Sept. 10 at the Trinity M. E. Church in Youngstown, Ohio. More than 150 section members and guests heard Thomas E. Purcell, nominee for the office of regional vice-president, A.S.M.E., and general superintendent of power stations of the Duquesne Light Company, Pittsburgh, Pa., speak on the progress and advance of engineering as a profession. Mr. Purcell also traced the history of the Society and stressed the value of the engineer to the public. A sound film, "Jet Propulsion," by the General Electric Company, closed the program.

Student Branches

Bucknell University Branch

The branch has adopted a new meeting announcement card which was prepared by John B. Clark, secretary-treasurer. It is a $5\frac{1}{2} \times 3\frac{1}{4}$ grey card, printed in black, with two words "You" and "Feature" in red for emphasis and drama. This card should aid attendance at branch meetings during the coming season.

University of Arizona Branch

On Sept. 29 in the Engineering Building, Robert Brown, chairman, opened the first meeting of the school year. The new officers for 1947–1948 are: Robert Brown, president; Ed Kintzele, vice-president; Ralph Feibelman, secretary; and Don Power, treasurer. Fifteen seniors were present.

Cooper Union School of Engineering (Day) Branch

The first meeting of the new semester was held on Sept. 29 and opened by the new chairman, Henry Wald. Mr. Wald gave a brief talk on recent branch activities and plans for the future. He spoke of the advantages of membership in the branch, and in a brief talk by Prof. W. A. Vopat, member A.S.M.E., honorary chairman, these advantages were emphasized. A new treasurer, J. Carl Apsley of the class of 1950, was elected. Forty-one were present.

University of Idaho Branch

The members of the faculty were introduced at the meeting on Sept. 29 in the Engineering Building. New members were welcomed by Prof. N. F. Hindle, member A.S.M.E., honorary chairman. Professor Gauss, member A.S.M.E., chairman of the Spokane branch, gave a short talk concerning what it meant to be a member of the A.S.M.E. A 40-minute movie entitled "Unfinished Rainbows," closed the program. Fifty were present.

Johns Hopkins University Branch

The first meeting of the season was held on Oct. 3 in Maryland Hall on the campus. The audience, numbering 50, was addressed by Professor Potter, honorary chairman, who explained the purposes, organization, and activities of the A.S.M.E. Promotional literature was distributed and registration and payment of dues completed the meeting.

University of Missouri Branch

At the first meeting of the season, Sept. 24, in Engineering Hall, E. R. Reager was elected vice-chairman, and Andrew Mosier was elected secretary. Ken Cowdery was appointed chairman of the program committee. Ernest Phillips, Fred Frizelle, and Don Hill were named to represent the branch on the program, publicity, and attendance and discipline committees, respectively, of the Engineers Club, a professional club for all engineering students of the university. Dr. R. L. Scorah, member A.S.M.E., chairman of the department of mechanical engineering, explained the advantages of student membership in the A.S.M.E. Fifty-seven were present.

University of Nebraska Branch

An attendance record of 97, unprecedented in recent years, marked the opening meeting of the new semester on Sept. 24 in room 206, Richards Laboratory. The chairman, James K. Jensen, welcomed old and new members and outlined the plans for the coming year. Prof. N. H. Barnard, member A.S.M.E., newly appointed chairman of the University's mechanical-engineering department, was guest speaker. He expressed the aims of the department concerning the students' academic welfare, and their activities in the A.S.M.E. branch. Prof. J. K. Ludwickson, member A.S.M.E., honorary chairman, spoke on the value of the A.S.M.E. as part of an engineering student's college activities.

Northeastern University Branch

At the Sept. 24 meeting in room 200, Richards Hall, new members were welcomed into the branch and old members greeted one another. A moving picture entitled "Water Fog," in color, was shown through the courtesy of the Rockwood Sprinkler Company. It illustrated the advantages of water fog over water streams for extinguishing oil fires. Chairman Callahan answered questions about

the branch. One hundred and ten members were present.

Oklahoma A.&M. College Branch

The annual fall smoker was held in the Life Sciences building on Sept. 29. Seventy-five student engineers and faculty members were present. Vocal selections were given by Paul Anderson. An outline of A.S.M.E. aims and advantages was presented by the branch secretary, and 45 applications and renewals of membership were accepted.

University of Oklahoma Branch

On Sept. 24 in the engineering auditorium Robert M. Wright, chairman, opened the first meeting of the new season and spoke on the plans for the school year. Prof. E. F. Dawson, member A.S.M.E., past honorary chairman, gave a short talk on A.S.M.E. activities and A.S.M.E. awards at district meetings. Prof. Frank Roop, junior member A.S.M.E., the new honorary chairman, spoke on teamwork and co-operation with the officers. He also stressed the wonderful opportunity to gain speaking ability as an active member of the branch. Tom Krieg was elected as St. Pat's representative. Thirty-five were present.

University of Pittsburgh Branch

On Sept. 25 177 students gathered in the Cathedral of Learning to attend the opening meeting of the branch. Chairman Ray Matthews presided. The first speaker was Prof. G. O. Manifold, junior A.S.M.E., honorary chairman, who spoke of the advantages and object of joining the A.S.M.E. Prof. N. L. Buck, member A.S.M.E., head of the mechanical-engineering department, also discussed the advantages of A.S.M.E. membership.

Virginia Polytechnic Institute Branch

The first meeting of the season was held on Sept. 30 in Davidson Hall with 161 old and new students present. Chairman Bill Boggs called the meeting to order, and then presented Prof. J. L. Jones, member A.S.M.E., who gave a short talk on the benefits derived from taking an active part in the branch. The next speaker was Prof. J. B. Jones, member A.S.M.E., head of the mechanical-engineering department, who told of the advantages of joining the A.S.M.E. and described its setup.

A.S.M.E. Sections

Coming Meetings

Akron-Canton: December 11. Dinner at 6:30 p.m.; lecture at 8:00 p.m., Women's City Club, Akron, Ohio. Subject: Taylor Model Basin of the U. S. Navy, by Captain H. E. Saunders, U.S.N. Special Assistant to the Chief of the Bureau of Ships.

Anthracite - Lehigh Valley: November 21. Reading, Pa. at 8:00 p.m. Subject: Advancement of the Foundry Industry, by A. L. Wentzel, assistant works manager, Birdsboro Steel Foundry and Machine Company.

Buffalo: November 12. Subject: "Machine Design and Applied Mechanics." (Speaker will be announced at a later date.)

Chicago: November 13. South Side Filtration Plant, Chicago, Ill., at 6:00 p.m. Annual Smoker with Sir Herbert Gepp, Australian mining engineer as the speaker.

Columbus: November 19. Battelle Memorial Institute Auditorium at 8:00 p.m. This is the annual joint meeting of the Columbus Technical Council. Subject: "Engineering for Tomorrow," by Charles A. Scarlott, manager of Engineering. Publications, Westinghouse Electric Manufacturing Company.

Fairfield County: November 19. Hotel Barnum, Bridgeport, Conn. at 8:30 p.m. Subject: Discussion of the Taft-Hartley Labor Bill by John Gannings.

Hartford: November 18. City Club, Hartford, Conn. at 6:30 p.m. Subject: Photography in State Police Investigations by Lieut. F. V. Chameroy and Lieut. F. W. Shaw of the Connecticut State Police.

Kansas City: November 7. Kansas University, Lawrence, Kan. at 7:00 p.m. At this meeting the Student Branch at Kansas University will be host to the Student Branch at Kansas State College, Manhattan, Kan., and the Kansas City Section of Kansas City, Mo. Subject: Discussion of Early Uses of Construction Materials by Ernest E. Howard, senior partner of Howard, Needles, Tammen & Bergendoff, Kansas City, Mo.

Louisville: November 21. Speed School A at 8:00 p.m. Subject: Heat Pump Installations by Prof. E. B. Penrod, University of Kentucky, Louisville, Ky.

Metropolitan: November 6. Joint meeting with New York Section, American Welding Society, Room 501[1] at 7:30 p.m. Subject: Welding and Fabrication of High Temperature Alloys, by C. G. Chisholm, Haynes Stellite Company, Kokomo, Ind.

November 13. Engineers' Forum, Room 1101,[1] 7:30 p.m. Subject: How Engineers Can Help Improve Industrial Advertising, by Carl H. Odell and Schuyler Hopper.

November 13. Woman's Auxiliary, Room 1101[1] at 1:30 p.m. Election and Annual Reports of Officers followed by talk. Subject: Family Life in Postwar Holland, by Mrs. H. R. Kessler.

November 13. Industrial Instruments and Regulators Forum, Room 1101[1] at 7:30 p.m.

November 14. Junior Group, Room 501[1] at 7:30 p.m. Subject: Power Plant Training.

November 18. Materials Handling Forum, Room 1101[1] at 7:30 p.m. Subject: Mechanization of Sand Handling and Preparation in Foundries, by W. Morley, foundry engineer, Olney Division Link-Belt Company.

November 19. Photographic Group, Room 1101[1] at 7:30 p.m. Subject: What's New in Cameras, by John V. Adams, manager of New York office, Graflex, Inc.

November 20. Joint Meeting—Special Dept. Metropolitan Section and American Rocket Society, Room 502[1] at 7:30 p.m. Subject: Rockets, by C. N. Hickman, Bell Telephone Laboratories.

November 25. Engineers' Forum, Room 1101[1] at 7:30 p.m.

New Haven: November 12. Dinner at 6:30 p.m. at Ceriani's Restaurant; meeting at 8:00 p.m., United Illuminating Company Auditorium, New Haven, Conn. Subject: Stress Analysis and the SR-4 Strain Gage, by Francis G. Tatnall, The Baldwin Locomotive Works, Philadelphia, Pa.

New Orleans: December 8. Jackson Room, St. Charles Hotel, New Orleans, La., at 8:00 p.m. This will be a joint meeting with the Louisiana Engineering Society. Subject: High Energy Atomic Particles and Their Industrial Applications, by Jack T. Wilson, physicist, Allis-Chalmers Manufacturing Co.

Ontario: November 13. Hart House, University of Toronto at 8:00 p.m. Subject: Welding Nonferrous Metals, by a speaker from the Dominion Oxygen Company to be announced.

Philadelphia: November 12. Philadelphia Engineers Club, 1317 Spruce St., Philadelphia, Pa. at 8:00 p.m. Subject: Atomic Energy. (Speaker to be announced later.) This is a meeting of the Philadelphia Section's Junior Group.

November 13. Stacy Trent Hotel, Trenton, N. J. This is a meeting of the Trenton Sub-Section. Subject: Wartime Developments Which Have Found Application in Industry, Commerce, or Education. (Speaker to be announced later.)

November 18. Professional Division Meeting at 8:00 p.m. Room 314, Engineering Building, University of Pennsylvania, Philadelphia, Pa. Subject: Some Aspects of Quality Control, by Joseph Manuele, director of quality control, Westinghouse ElectricCorporation, Pittsburgh, Pa.

November 19. Wilmington Sub-Section. Subject and speaker to be announced.

November 25. Philadelphia Engineers Club at 8:00 p.m. Subject: Development of South African Industries, sponsored by W. M. Sheehan, General Steel Casting Company, Philadelphia, Pa. (Note: Mr. Sheehan has just returned from an extensive trip to Africa this summer).

Pittsburgh: November 10. Urban Room, William Penn Hotel, Pittsburgh, Pa. Subject: Industrial Outlook for Pittsburgh; speakers: J. E. Lose, vice-president, Carnegie Illinois Steel Corporation; Joseph Pursglove, Jr., vice-president, Pittsburgh Consolidation Coal Company; and Birger Engstrom, vice-president, McDowell Manufacturing Company and president, Smaller Manufacturers Council.

Plainfield: November 19. Elk Club, Elizabeth, N. J. at 8:15 p.m. Subject: Servomechanisms, by T. M. Berry, laboratory consultant, General Electric Company, Schenectady, N. Y.

St. Joseph Valley: November 18. Technical lecture. Subject: Engineering as a Profession, by R. E. Orton, Orton Crane and Shovel Company, Chicago, Ill. This will be a joint meeting at Notre Dame University with the Student Branch.

Youngstown: November 13. Meeting to be held at 8:30 p.m., place to be selected at later date. Subject: The German Aircraft Industry, by Charles L. Fay, assistant to chief engineer, Bell Aircraft Corporation, Buffalo, N. Y. (Note: Data were gathered by speaker when he was scientific consultant for Army Air Forces.) Colored slides are to be used.

[1] Engineering Societies Building, 29 West 39th St., New York, N. Y.

Engineering Societies Personnel Service, Inc.

These items are from information furnished by the Engineering Societies Personnel Service, Inc., which is under the joint management of the national societies of Civil, Electrical, Mechanical, and Mining and Metallurgical Engineers. This Service is available to members and is operated on a co-operative nonprofit basis. In applying for positions advertised by the Service, the applicant agrees, if actually placed in a position through the Service as a result of an advertisement, to pay a placement fee in accordance with the rates as listed by the Service. These rates have been established in order to maintain an efficient nonprofit personnel service and are available upon request. This also applies to registrants whose notices are placed in these columns. All replies should be addressed to the key numbers indicated and mailed to the New York office. When making application for a position include six cents in stamps for forwarding application to the employer and for returning when necessary. A weekly bulletin of engineering positions open is available to members of the co-operating societies at a subscription of $3.50 per quarter or $12 per annum, payable in advance.

New York	Chicago	Detroit	San Francisco
8 West 40th St.	211 West Wacker Drive	109 Farnsworth Ave.	57 Post Street

MEN AVAILABLE[1]

MECHANICAL ENGINEER, Tau Beta Pi. Year and a half experience in heat-transfer research by electrical analogy. Also consideriable experience in electronic sealing of thermoplastics. Possesses executive ability and initiative. Me-228.

ENGINEERING EXECUTIVE, chemical engineer, 20 years' broad experience in project management; supervision of process development, equipment design, and application; administration of plant design, construction, and operation. Me-229.

MECHANICAL ENGINEER, 43, desires any combination of executive, engineering, and operation; 22 years' experience includes operating, maintenance, and personnel supervision of modern power plant; general engineering on construction and power in chemical plant; plant engineering and all-round operation in by-product coke plant. Me-230.

SALES ENGINEER, graduate, with experience in railway, and industrial-equipment sales and machine-shop background, desires connection with industrial-equipment or specialty manufacturer for New York area or Eastern District. Me-231.

MECHANICAL ENGINEER, B.S.M.E., 27, married, recent graduate. Some experience in heat-control equipment. Military experience in construction and construction equipment. Desires position with a future. Me-232.

INDUSTRIAL ENGINEER, B.S. and M.S. degrees, 25 years' experience in organization and administration of comprehensive program of industrial engineering including plant layout, incentives, methods, time study, material handling, standards, budgets, job evaluation, wage administration, cost reduction, foreman training, reports. Professional license Pennsylvania. Able organizer and administrator. Available as chief industrial engineer or as assistant to top-line executive. Me-233.

EXECUTIVE ENGINEER, Ph.D., mechanical and chemical, age 41. Topnotcher, excellent record, design, research, development, new products or plants. New with large concern. Seeks position as director of research, medium-sized company. Me-234.

MECHANICAL ENGINEER, with masters in I.E. Now employed. Five years' experience process and production engineering. Desires position in production and industrial engineering, or with consultant. Me-235.

MECHANICAL ENGINEER, graduate, 27, married. Desires a position offering a career in the oil and gas or steam-power field. One and a half years in present position as chemical-plant-development, engineer; including design calculations, layout and specifications; four years as Army aircraft maintenance officer. Prefer Southwest or West Coast. Me-236.

MECHANICAL ENGINEER, graduate 1943, age 25. Four years' diversified experience in design, development, and test of engine-fuel systems, hydraulic and electromechanical controls. Desires position as designer. New York, N. Y. preferred. Me-237.

WORKS MANAGER, 25 years' experience factory management, high-production precision-machine shops and foundry. Excellent production and labor-relations record. Graduate mechanical engineer, Cornell. Me-238.

MECHANICAL ENGINEER, graduate, 23, single. Experience covers machine shop, methods engineering, tool design, and air conditioning. Desires position with well-established concern having a machine shop, in order to increase knowledge of shop practice. Available on short notice. Me-239.

MECHANICAL ENGINEER, age 26, married. Graduate, M. E., 1943. Experienced design and research. Familiar with machine-shop methods. Desires position with firm in Northeast U. S. Me-240.

POSITIONS AVAILABLE

INSTRUCTOR OR ASSISTANT PROFESSOR, young, to teach classes in mechanical drawing and descriptive geometry and possibly to assist in the mechanical-engineering laboratories. $2400–$2800 for 9 months, depending upon training and experience. Colorado. W-9629.

ENGINEER, mechanical or industrial graduate about 25, to plan and schedule work in a textile industry. Should have some experience in industry, but not essential. Start, $3000. Pennsylvania. W-9630.

PLANT ENGINEER, 38–45, preferably with from 5 to 10 years' experience in industrial-plant maintenance. $5500–$6000. Northern New Jersey. W-9631.

ENGINEERING DRAFTSMAN, mechanical graduate, with 3 to 5 years' plant-engineering experience, to lay out piping, filters, conveyers, etc., in metallurgical plant. $3900–$4160 a year. Northern New Jersey. W-9634.

RESEARCH ENGINEER, mechanical graduate, with one or two years' experience preferably in the railroad industry, for freight claim-prevention surveys and recommendations. Apply by letter stating educational and training qualifications. $4200. Massachusetts. W-9637.

EDITORIAL ASSISTANT, preferably mechanical graduate, 25–30, to edit articles and reports covering design and specification of products and equipment. $3000–$3600. New York, N. Y. W-9639.

MECHANICAL ENGINEERS, young, graduates, with a real bent for design work, for manufacturers of automatic-precision machinery, specializing in ammunition processing and ordnance machinery. Northern New Jersey. W-9644.

DRAFTSMAN, mechanical, for design work. Must have had some experience on the board. Salary open. Will also consider a junior mechanical draftsman. New York metropolitan area. W-9648.

INDUSTRIAL ENGINEERS, 30–40, mechanical or industrial graduates, with production planning, wage incentive, budgetary control, standard cost- and job-evaluation experience for staff position with manufacturer of fiber and metal containers. $5000. Headquarters, New York, N. Y., with considerable traveling. W-9657.

MECHANICAL ENGINEER, 21–30, for design of special textile machinery with large textile company. Experience desirable but not necessary. Salary commensurate with ability. Pennsylvania. W-9660.

RECENT GRADUATE for power-plant operations for a large process-manufacturing company. $3120–$4000 a year. Maryland. W-9667(a).

DESIGN DRAFTSMAN for plant layout, maintenance, and improvements in plant-engineering department for process manufacturing. $3000–$3780. Pennsylvania. W-9672.

ENGINEERS. (*a*) Diesel engineer for Diesel instrument-application investigations, to check performance of currently manufactured Diesel instruments; to find need for new types and designs of industrial instruments; determine their proper use, and establish their field acceptance through personal contact with plant executives. (*b*) Junior development engineer, having machine-tool and drafting experience. Apply by letter giving details of training and experience. Pennsylvania. W-9676.

MECHANICAL DESIGNERS, with considerable experience in the layout of plumbing, heating, and ventilating. This experience must have been in industrial building only. $4800–$5200. New York, N. Y. W-9686(b).

ENGINEERS. (*a*) Mechanical engineer, graduate, with 2 to 4 years' experience in the

(*A.S.M.E. News continued on page 982*)

[1] All men listed hold some form of A.S.M.E. membership.

HIGH PRESSURE BOILER PLANTS *USE YARWAY BLOW-OFF VALVES*

It's a fact! Four out of every five high pressure boiler plants in the United States are equipped with Yarway Blow-Off Valves.

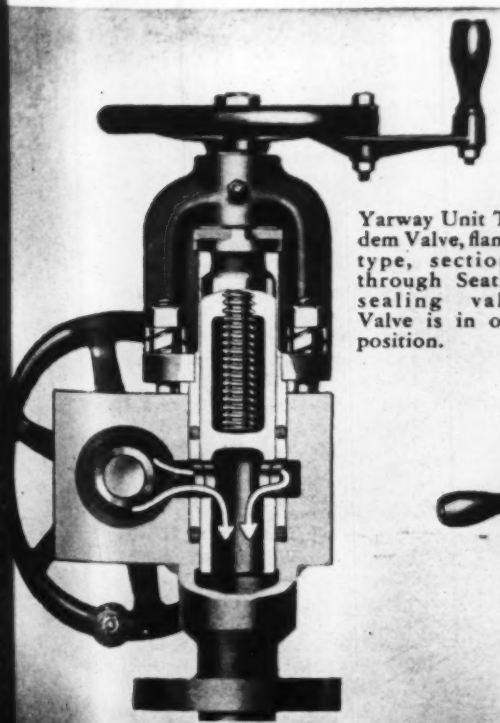
Why such an overwhelming acceptance? *Dependable performance.*

The proved performance of Yarway Blow-Off Valves is due to outstanding design, sound engineering and careful manufacture.

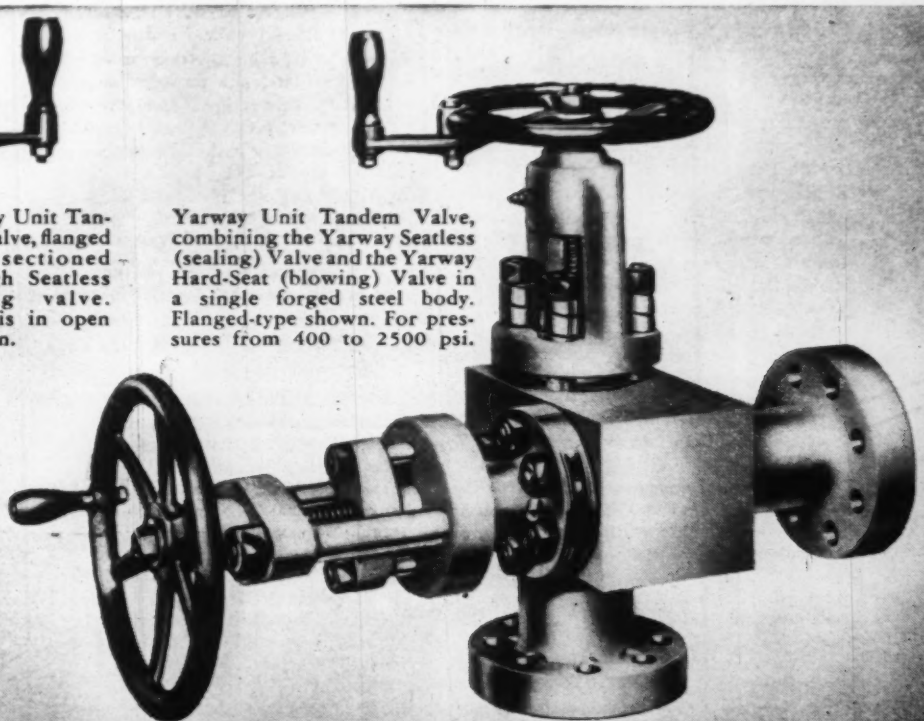
The famed Yarway *Seatless* principle eliminates a major source of blow-off valve trouble. Yarway Seatless Valves have no seat to score, wear, clog and leak. And constant research, leading to mechanical and metallurgical advancements, keeps Yarway Valves ever ahead of changing service requirements.

Next time you order blow-off valves, remember—power engineers vote 4 to 1 for Yarways. You'll find all the details in Yarway Bulletin B-432.

YARNALL-WARING COMPANY
108 Mermaid Avenue, Philadelphia 18, Pa.



Yarway Unit Tandem Valve, flanged type, sectioned through Seatless sealing valve. Valve is in open position.



Yarway Unit Tandem Valve, combining the Yarway Seatless (sealing) Valve and the Yarway Hard-Seat (blowing) Valve in a single forged steel body. Flanged-type shown. For pressures from 400 to 2500 psi.

YARWAY BLOW-OFF VALVES

electronic field, preferably in the design and development of radar equipment, for design and development of radar equipment for ground and marine use. Salary, up to $3900. (*b*) Mechanical design engineer, graduate, with a minimum of 2 years' experience in receiver design for production quantities. Work will be on design and development of new components (miniature type) for Navy receivers. Salary, up to $3640. Pennsylvania. W-9692.

ENGINEERS. (*a*) Production engineer, mechanical graduate, with cement-asbestos manufacturing experience, to supervise production of pipe, boards, etc. $6000–$8000. (*b*) Junior industrial engineer, with building-products-manufacturing experience, to do time study, methods, and assist production engineer. $4200–$4800. East. W-9698.

ENGINEERS. (*a*) Mechanical engineers, 35–45, must have at least 6 to 10 years' experience. Will be required to have a good knowledge of machine-shop work. Should be well qualified and interested in design work. Some gadgeteering in research facilities division. Supervisory ability important. $4800–$6000. (*b*) Mechanical engineer, 30–40, with at least 5 years' experience in industrial work. Will be used as assistant area engineer to do a great deal of liaison work between maintenance department and other various divisions. $4200–$4800. South. W-9705.

GENERAL SUPERINTENDENT of freezer department, 35–50, mechanical engineer or equivalent training and experience. Should have 10 to 15 years in factory work in mass production of refrigerators, freezers, etc., on an assembly line, and at least 3 to 5 years of successful experience as superintendent in this type factory. Duties will be to maintain production, supervise foremen and production workers, and assemble deep-freeze units. Salary $8000–$12,000. Upstate New York. W-9706.

MECHANICAL OR CIVIL ENGINEER, to act as superintendent in the field in the erection of steel-prefabricated houses. Must be able to devise the simplest and most efficient erection procedure based upon the time-study methods used in the manufacturing industries. Salary open. Headquarters, Delaware. W-9715.

STUDENT ENGINEERS, mechanical graduates, single, interested in hydraulics, power and air conditioning, refrigeration equipment, for training with large heavy-equipment manufacturer, for sales and production. Northern New Jersey. W-9717.

STAFF ENGINEER, 30–40, mechanical graduate, with plant-engineering experience, preferably in brewery, to supervise maintenance of power plant, refrigeration, new-equipment installations, and building construction. $5000–$6000. New York Metropolitan Area. W-9718.

MECHANICAL ENGINEER, graduate, with several years' design and layout work of refrigeration and air-conditioning systems, 30-ton systems and larger, to direct activities of junior engineers and draftsmen in preparation of working plans for large air-conditioning and refrigeration installations, including piping, duct work, wiring and controls, ordering of materials, and scheduling for installation. Will collaborate with senior engineers in setting up basic designs. Salary, from $5000, depending upon qualifications. Florida. W-9722.

ENGINEERS. (*a*) Senior designer, 33–50, graduate, with 10 or more years' designing experience on small high-speed-production machinery, tools and dies, etc., to take sketches of ideas and make layouts and detailed designs of dies and machinery. $4800. (*b*) Junior designer, 25–45, with 2 or more years' designing experience on small high-speed-production machinery, tools, and dies, etc., to take sketches and make layouts and some detailed designs of small interchangeable parts, dies, and automatic machinery. $3900. (*c*) Senior draftsman for similar work. $3300. Pennsylvania. W-9731.

ASSISTANT CHIEF ENGINEER, mechanical, chemical, or electrical graduate, with 20 years' experience in design, maintenance, construction or power work, at least 15 of which should have been in chemical manufacturing, by-product coke oven, or refinery activity, to handle administrative details in connection with design, maintenance, construction, and power departments. $10,000–$12,000 a year. Pennsylvania. W-9737.

PRODUCTION SUPERVISOR with 10 or more years' production experience in a chemical plant or oil refinery, including supervision of major production, for supervision of and responsibility for, the efficient operation of a group of production departments handling both organic and inorganic chemical products. Pennsylvania. W-9745.

MECHANICAL ENGINEER, 35–40, to purchase equipment and machinery, also to discuss improvements and new methods with American manufacturers as a representative of a South American manufacturing organization. Some traveling. $6000. New York, N. Y. W-9748.

ENGINEERS. (*a*) Production engineer, 35–40, mechanical or industrial-engineering graduate, with about 5 years' experience, preferably on design and layout of high-speed-automatic machinery. $6000. (*b*) Assistant chief engineer, 30–35, mechanical graduate, with several years' experience in automatic-machinery design, i.e., printing presses, packaging machinery, etc. $5000–$6000. (*c*) Recent graduate, industrial or mechanical, to be trained either in production or engineering design, for machinery concern. Salary open. Pennsylvania. W-9757.

ASSISTANT EDITOR for magazine devoted to plant engineering covering distribution and uses of power-plant services in the manufacturing plant. Work will cover repair and maintenance, installation of new machinery, and probably plant sanitation. Preference will be given to a veteran who has had maintenance experience in the Service and after coming back, 2 or 3 years of plant-engineering experience. Should have the ability to write in good English and have good knowledge of industrial-plant work. $3500–$4500. Chicago. R-4489C.

Candidates for Membership and Transfer in the A.S.M.E.

THE application of each of the candidates listed below is to be voted on after Nov. 25, 1947, provided no objection thereto is made before that date, and provided satisfactory replies have been received from the required number of references. Any member who has either comments or objections should write to the secretary of The American Society of Mechanical Engineers immediately.

KEY TO ABBREVIATIONS

Re = Re-election; Rt = Reinstatement; Rt & T = Reinstatement and Transfer to Member.

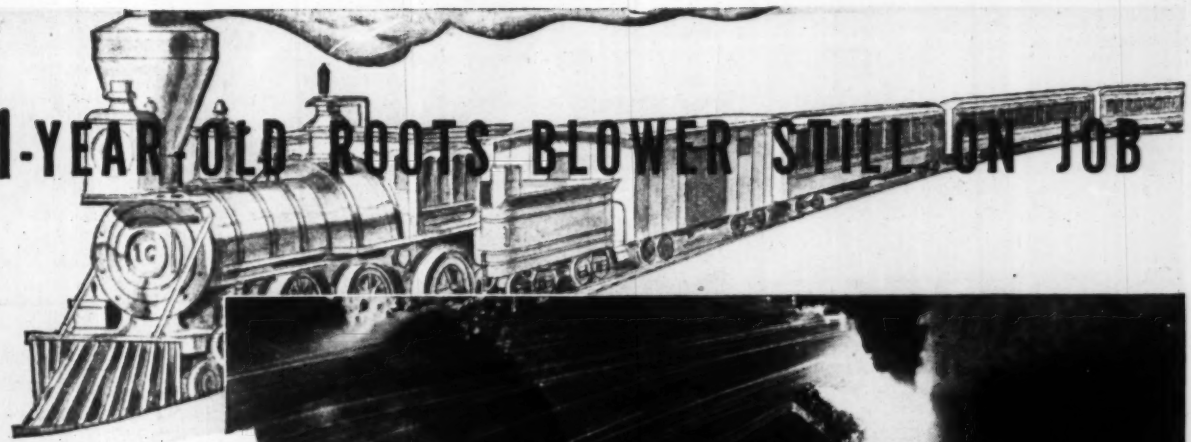
NEW APPLICATIONS

For Fellow, Member, Associate, or Junior

ABBOTT, H. P., East Boston, Mass.
ANDERSON, LAWRENCE A., Wilmette, Ill.
ASSELIN, F. X., Fall River, Mass.
BAILEY, O. R., Trenton, Mich.
BALLASEYUS, A. C., Oxnard, Calif. (Rt. & T)
BARNEY, WILLIAM G., Grand Forks, N. D.
BECKER, WILLIAM L., Oak Ridge, Tenn.
BERGTHOLDT, GEORGE C., Tulsa, Okla.
BILLINGS, DAVID P., San Francisco, Calif.
BITTNER, BURTON ANDREW, New York, N. Y.
BLAKESLEE, WALTER A., Newtown Square, Pa. (Rt & T)
BOERKE, THOMAS S., Bucksport, Maine
BOWKER, JOHN E., Upper Darby, Pa.
BULLER, ELMER H., Dayton, Ohio
BURTON, CHARLES A., New Orleans, La.
CALL, WILLIAM RAYMOND, North Wales, Pa.
CAMPBELL, ASHLEY S., Cambridge, Mass.
CARMICHAEL, D. C., Wilmington, Del. (Rt)
CHADWICK, WALLACE L., San Marino, Calif.
CLARK, JACK FRED, Mt. Vernon, N. Y.
COHEN, PAUL, Pittsburgh, Pa.
CONTA, BARTHOLOMEW J., Syracuse, N. Y.
COONCE, WILLIAM V., Elmwood Park, Ill.
CORBIN, W. L., Philadelphia, Pa.
CREW, M. W., Milwaukee, Wis.
CROUCH, JOEL E., Hoboken, N. J.
DE GROAT, GEORGE, East Orange, N. J.
DIVER, J. R., Waukegan, Ill.
DORR, HOWARD G., Akron, Ohio
DUCH, PETER, JR., Bay City, Mich.
DUNCAN, ALLEY H., Manhattan, Kan.
ERHARD, ROBERT W., Greensburg, Pa.
FALLS, ROBERT E., New York, N. Y.
FELTS, WOODROW R., Richland, Wash.
FITZBURGH, WILLIAM J., Detroit, Mich.
FLARSHEIM, CLARENCE A., Kansas City, Mo.
FOGAL, GORDON L., Washington, D. C.
FOX, BRYCE J., Grand Forks, N. D.
FRANK, THOS. B., Rockville Centre, N. Y. (Rt)
FRENCH, EARL B., Brooklyn, N. Y.
GENGE, J. P., Niagara Falls, Ont., Can.
GIANNINI, GABRIEL M., Pasadena, Calif.
GIGER, W. A., Wauwatosa, Wis.
GOLONKA, EDWARD M., Milwaukee, Wis.
GOODERE, W. E., Los Angeles, Calif.

(*A.S.M.E. News continued on page 984*)

71-YEAR-OLD ROOTS BLOWER STILL ON JOB



. . . making mineral wool from iron slag

This cupola blower, fitted with wooden impellers, was installed in 1876 at the Stanhope (N. J.), plant of U. S. Mineral Wool Company (world's oldest manufacturer of mineral wool). Used in making mineral wool insulation from iron slag, it's still working faithfully, 24 hours a day, 7 days a week.

Amazing as this record is, we'll stack our modern blowers against it. Advanced engineering, new materials and methods make R-C Blowers better than ever before. Then, our *dual-ability* to build either Rotary or Centrifugal units permits matching the blower precisely to the job —for better all-round performance, economy and long life.

ROOTS-CONNERSVILLE BLOWER CORP.
711 Michigan Avenue, Connersville, Indiana

Insulation process completed by R-C Blowers

Air from compact, built-in R-C Blowers carries this same mineral wool into every nook and corner for building insulation. Similar units furnish air for widely varying uses—from ice-making to portable forges. High-capacity Rotary or Centrifugal equipment moves or measures air and gases in almost every industry, with a proved record for durability and economy.

You'll find it profitable to consult us on any problem of moving gas or air.

ROOTS-CONNERSVILLE ROTARY CENTRIFUGAL

BLOWER BUILDERS R-C SINCE 1854

BLOWERS · EXHAUSTERS · BOOSTERS · LIQUID AND VACUUM PUMPS · METERS · INERT GAS GENERATORS

★ ★ ONE OF THE DRESSER INDUSTRIES ★ ★